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ABSTRACT

The first half of this review of the recent literature on word attack skills describes 11 major reading systems currently in use and evaluates and compares them. The second half reviews reports of current word attack research under the headings of traditional phonic generalization research, current linguistic formulations, unit size, Gibson: Cornell group, learning grapheme-phoneme correspondence rules, and Stanford project. An abundance of non-experimental, prescriptive articles is noted, while empirical investigations are limited and tend to cluster in a few areas, most notably those of word and letter discrimination. An extensive bibliography, divided into nine sections, is included. (CM)

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WORD ATTACK SKILLS: REVIEW OF LITERATURE

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WORD ATTACK SKILLS: REVIEW OF LITERATURE

Peter Desberg and Betty Berdiansky

PREFACE

It is crucial to a child and his community that reading skills be acquired as quickly and efficiently as his ability and educational technology will permit. A major facet of reading instruction deals with the pedagogical problem of conveying how the speech and writing systems are related at the word-level of analysis. Unfortunately, just how the two systems are related at that level cannot yet be stated. Hence, the development of instruction is currently based upon incomplete and intuitive views regarding a critical underlying subject matter. Not knowing exactly which rules of correspondence relate the speech and writing systems, we can only say that we prepare the child in school to develop an efficient word attack to the extent that he can intuit orderliness on the basis of explicit but crude overgeneralizations. Many children can (how efficiently we do not yet know); some children absolutely cannot.

This Technical Report stems from a SWRL Word Attack project whose objectives are: (a) to define an explicit and relevant word attack subject matter--a set of rules relating the speech and writing systems at the word level--that will serve as a useful working approximation to an ultimate statement on the matter; (b) to determine efficient means for imparting this subject matter to children in the classroom; and (c) to develop identification-process reading instruction which is predicated upon (a) and (b).

Much has been published under the rubrics of reading conceptualization and research. This report surveys trends in that portion of the recent reading literature which deals with the identification process. It serves as a general orientation to problems and to alternative strategies for attacking these problems.

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INTRODUCTION

Conceptualizations of the reading process have focused on two categories, identification and comprehension, considered either separately or in concert (Weiner & Cromer, 1967 I).[1] Taken together, these categories, though not mutually exclusive, do form an exhaustive definition of reading. Identification and comprehension are usually stated, or implied, in the form of operational definitions or terminal objectives of the reading process. A composite view of identification reveals an emphasis on the decoding of stimulus configurations (letters, letter patterns, words, clauses, sentences) in print (Carroll, 1964; Levin, 1965 I). Comprehension has been conceived as the derivation of meaning from morphemes, words, phrases, sentences, and higher order syntactical units (Lefevre, 1964 IV).

An author's selection of a conceptualization of the reading process is contingent upon the nature of his overview of reading. In most cases, conceptualizations of reading occur on three dimensions: length and scope of coverage, author's emphasis, and sequence and proportion. Length and scope of coverage takes into account the duration and breadth of instruction, and the nature of the terminal objectives. Programs may range from a period of months, having "the ability to read new or transfer words" as a terminal objective (Silberman, 1963a, 1964a I), to a program of longer duration which produces accomplished readers and extends beyond acquisition to the point at which only comprehension is considered (Fries, 1963 I). "Although some form of identification (saying a word either aloud or subvocally) may be essential for comprehension during acquisition, its nonoccurrence is not a problem for an experienced reader. Thus, the final project of reading need not include components that went into its acquisition [Weiner & Cromer, 1967 I]."

The author's emphasis within the reading process is a function of his theoretical frame of reference and acts as a predisposing factor toward a definition of reading. For example Leonard Bloomfield, a structural linguist, eschewed meaning and focused his instruction on the regularities of the English sound system (Bloomfield & Barnhardt, 1961 IV). Eleanor Gibson, a psychophysicist, stressed the role of perception in discrimination (Gibson, 1962a, 1962b, 1963, 1965, 1966 V, VIII). The third dimension of reading conceptualizations, sequence and proportion, is the progression of steps within a program and the extent to which identification and comprehension are found at each step.

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[1] The Roman Numeral refers to the section of the bibliography in which the reference appears.

Figure 1 illustrates the general format of most reading programs; in such programs there is a progressive shift from an initial emphasis on identification to a final emphasis on comprehension.

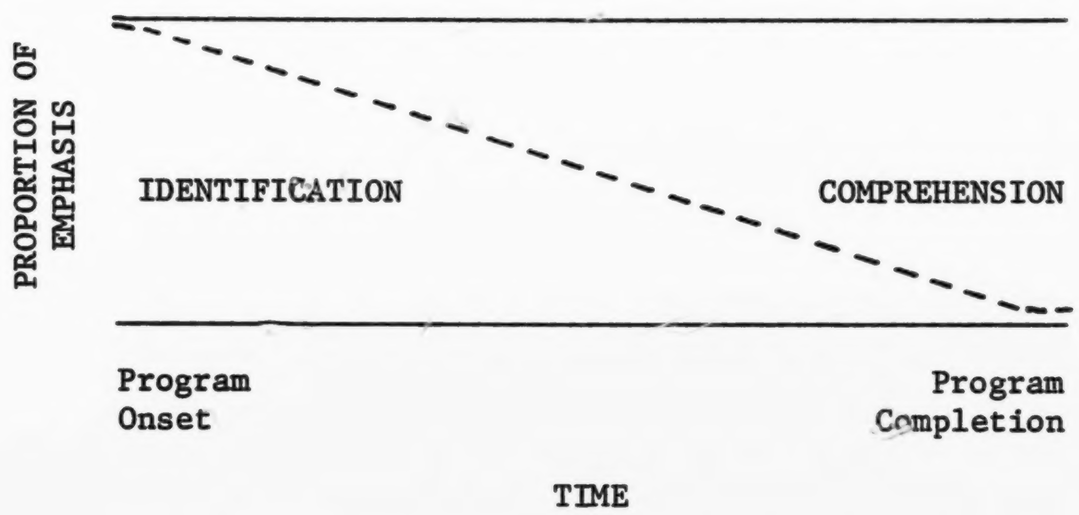

Fig. 1. General sequential emphasis of reading programs.

Figure 1 should not be construed as a "universal pattern," for there are a number of exceptions (e.g., Lefevre, 1964 IV; McKee, 1963 III; Scott & Foresman, 1962 III; Ginn, 1966 III; and Allyn & Bacon, 1957 III). It does, however, typify the majority of reading programs today. This report will deal only with the identification process as it is portrayed in Figure 1 and how the current literature on this process relates to a proposed word attack system.

Word attack may be defined in terms of a conversion of graphemic units to phonic units, or as a decoding process; however, these definitions do not make the domain of word attack explicit. A more useful understanding of the domain presumes an understanding of the relational components of word attack.

These components, or stages, can be represented as a chronological system; however, this is an oversimplification which fails to reflect that, beyond the onset of presentation of any stage, it is treated concurrently with the treatment of other stages. For purposes of exposition, the stages may be viewed chronologically as shown in Figure 2.

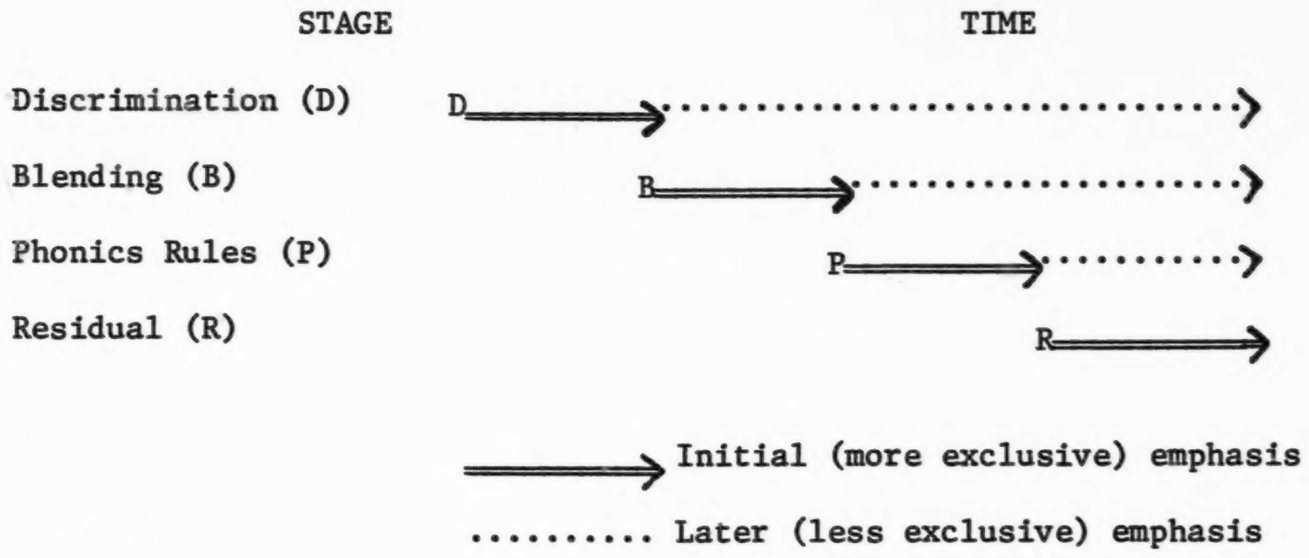

Fig. 2. Stages of Word Attack Instruction.

Each stage will be defined on the basis of stimulus groups with which it will be concerned: letter, letter group, and word for discrimination and blending; and letter group and word for phonics rules and residual.

Discrimination can be subdivided into visual and auditory dimensions.

1) Visual discrimination:

a) Letter--Visual discrimination of letters is concerned with questions of number of letters to be presented during initial stages, order of introduction (including confusable letter pairs), alphabet modification, effect of stimulus isolation, frequency;

b) Letter Group and Word--Visual discrimination of larger forms is concerned with questions of optional and maximal number of letters per unit, word shape (number of protruding letters, curvature and angularity, word length), frequency, effect of subvocalization on perception (pronunciability and differential perception of word classes).

2) Auditory discrimination:

a) Letter--Auditory discrimination of letter-sounds involves phonetic similarity and alternative correspondences;

b) Letter Group and Word--Considerations include length and intraword position.

Blending is the synthesis of individual letter sounds into higher order units, and/or the synthesis of higher order units into words. Little empirical work has been done in this area and its domain cannot yet be well-defined. How useful blending is to an efficient word attack remains to be determined. Certain of the following areas of research should be productive:

1) Selection of units: single letter and/or letter group.

2) Articulatory characteristics of letters: pronunciability in isolation and in groups:

  a) Stops vs. continuants.
  b) Sequencing letters on a blendability dimension.
  c) Production vs. recognition variables.
  d) Use of nonsense syllables.
  e) Use of polysyllabic words.

Phonics Rules represent an attempt to formulate rules regarding regularity of correspondence between the English orthographic system and its pronunciation system. This is the area in which the most progress is currently being made, notably through the work of Venezky and the late Ruth Weir (1967, 1966, 1964 V). They have proposed the hypothesis that the English orthographic system possesses a great deal more regularity than it was previously credited with, but also a great deal more complexity (see pages 38-43, this report). The rules used to describe this regularity are themselves of an arbitrary nature; thus, no attempt is made to establish an absolute system. A set of phonic rules will eventually be used as a descriptive model of the language to predict hypotheses regarding the best utilization of these rules for reading instruction.

Residual, as the term implies, is a stage that comprises the cases which do not fit into the other categories. Most of these instances will be low frequency, irregular words which must be learned on a sight recognition basis. Words with complex morphophonemic deviations may also be classified in this category.

The current literature review revealed that only a few of the aspects of the identification process have been studied in depth, and that these aspects primarily fall under the heading of discrimination: letter discrimination, alphabet modification, letter and word frequency, word length and shape, and auditory discrimination. Blending is given little consideration in the literature, and phonics rules have only recently begun to receive systematic attention. It appears that reading programs have, in general, tended to incorporate few research findings beyond the level of program-specific investigations.

This report, intended as a survey of beginning reading mechanics literature, is divided into two major sections. The first presents a review of general reading models as conceptualizations of the reading process. The programs have been selected to be representative of the range of approaches currently used in word attack instruction. Each program discussed is referred to by the label most commonly attributed to it in the literature. Central to this discussion is the qualification and criticism that most of these systems are not based upon empirically validated subject matters or instructional procedures.

The second major section of the report discusses selected current word attack research which has important analytic implications for reading mechanics instruction. The focus is primarily on appropriate psycholinguistic units for initial reading instruction.

The bibliography of beginning reading mechanics literature is divided into nine categories. It is a compilation of the references surveyed in preparing the report. The starred entries, those most relevant to purposes of this review, were closely examined and are discussed in the report. An entry is cross-referenced to more than one section when appropriate.

A second report which will consider in detail that literature which is central to defining the subject matter for a blending-phonics stage of identification-process reading instruction and a third report which will summarize findings regarding the discrimination stage of such instruction are under preparation. These two reports should aid both current instructional development and research underlying later, more efficient, treatments of reading instruction.

REVIEW OF GENERAL READING MODELS

BASAL READERS

The most widely utilized system of reading instruction today is the basal-reading series. Dykstra states that the primary characteristics of basal reading programs are the following:

1) Vocabulary is introduced slowly and repeated often. Vocabulary control is based on frequency of usage rather than on regualrity of sound-symbol relationships;
2) Phonic analysis is introduced gradually and usually only after some "sight" words have been taught. However, from the beginning the child is encouraged to use such other word recognition skills as context, structural analysis, and picture clues;
3) Emphasis from the beginning is placed not only on word recognition but also on comprehension and interpretation of what is read;
4) Silent reading is emphasized in the program;
5) The various reading skills are introduced and developed systematically [Dykstra, 1967 VII]

Chall (1967 VII) elaborates, stating the following characteristics of Basal Readers:
1) A basal reading program is a total package which is highly structured; 2) Its beginning and utlimate goal is meaning; 3) Motivational appeal at the beginning is primarily on content; 4) Difficulty is controlled via words (rather than phonic elements, spelling patterns, letters, or language patterns); 5) The major criterion for selecting words is word frequency vs. spelling regularity); the vocabulary load for the first year is low; 6) The content for the first year consists of stories based on familiar experiences; the picture load is high; 7) Grapheme-phoneme correspondences are learned analytically using a moderate number of verbalized rules; 8) The teacher guidance in phonics is moderate and the phonic load for the first year is low; 9) There is little concentrated practice on individual correspondences and little opportunity is provided for transferring phonic conepts to new words; 10) A "set" for diversity (rather than regularity) is established, primarily utilizing meaning cues rather than structural cues; 11) The types of structural cues employed are visual analysis and substitutions (rather than sounding and blending, or spelling); whole words, not letters, are taught first; 12) Silent reading is preferred at the beginning of the program; 13) There is a limited amount of writing employed; 14) There is a high programming of meaning, appreciation, and application responses;

15) Reading readiness is defined in global terms.

The theory underlying the analytic method utilized in basal series phonics programs suggests that "the child should be taught whole words and then, through various analytic techniques, recognition of letters and the sounds they represent [Bliesmer & Yarborough, 1965 VII]." Thus, children are expected to arrive at phonics rules inductively. Proponents of this method are Allyn and Bacon's Sheldon Basic Readers, American Book Company's ABC Betts Basic Readers, Ginn's Ginn Basic Readers, and Scott, Foresman's The New Basic Readers: Sixties Edition. Chall (1967 VII) quotes authors of these basal series to further explain the rationale of their phonics programs. These authors emphasized that their phonics teaching, as well as being secondary and analytic, is "functional"; i.e., the sounds learned come from the words used in the stories.

> Children generalize phonic rules from examples of known words; i.e., words they have learned as wholes. Some of the generalizations come as discoveries. Some are teacher-directed.[2]

The amount and kind of phonics to include in their reading programs was determined:

> From tradition. We included those used by primary teachers over the past fifty years. We believe it has 'consensual validity.' We got our team together and talked about it. Those of use who knew a lot about phonics hammered it out. Two of us who knew the research found no specific knowledge about what elements should be taught first or second. Therefore, we thrashed through what we thought should be included, mapped it out roughly by grades to see whether it was logical, and made our decisions. [See Footnote 2]

Another said:

> I made an analysis of when various phonetic and structural elements were introduced in five leading basal series, and I pretty much did the same thing. Consonants in the first grade; vowels in the second grade; vowel digraphs and

---

[2] Chall does not give the source of her quotations other than to say that they were authors of basal reading series.

> diphthongs in the second and third grades; vowel rules developed inductively in the second grade. Syllabication is developed from the second grade on, and given heavy emphasis in the third grade. It is continued throught the fourth, fifth, and sixth grades. We repeat and emphasize phonic rules through the sixth grade. In the seventh grade the first lessons review everything.
>
> After we set up our plan, if something differed markedly from Scott, Foresman, we looked at it closely. Another source was Bloomfield and other linguistic scientists. [See Footnote 2]

The Basal Readers provide instructional procedures and curricular programs with no empirical validation, as the preceding quotations have shown.

LANGUAGE EXPERIENCE APPROACH

An instructional approach which stresses reading for meaning to an even greater extent than the basal series is the Language Experience Approach. The meaning emphasis is the basis for little or no vocabulary control and for the absence of differentiation between oral and silent reading in the primary grades:

> It is an unconscious transfer (from oral to silent reading) as soon as he learns the skill, because everything is read for meaning. Language Experience children are after meaning all the time...If a word is known and interesting to a child, even if it is a 'difficult' word, he will learn and remember it. [See Footnote 2]

Beginning and later reading are considered to be the same: "If there is any difference at all, it is only in the number of concepts understood: 'The mature reader has more concepts'[See Footnote 2]."

> Recognition and understanding are completely one. The recognized word is always related to understanding. Understanding of the word always comes first, because the child has experienced it and has expressed it. There is no separate drill in this program on word recognition apart from meaning, except as words are extracted from a meaningful context. There is practice and repetition of words, but only after the initial experience with the same words in meaningful and larger units. The writing is indispensable to this. Writing and copying

take the place of phonics drill. [See Footnote 2]

Dykstra summarizes the Language Experience Approach:

> A basic element of this instructional method is that the child's own writing serves as a medium of instruction. The child's first stories are dictated to the teacher who acts as the recorder. As soon as he is able, the pupil writes his own stories and shares them with the teacher. During the individual conferences between pupil and teacher he is helped to recognize the commonality between the words he writes and speaks and he develops the skills necessary for reading. This approach, then, ordinarily utilizes far fewer highly structured instructional materials than do most reading programs. In addition, vocabulary control is viewed as being in the language itself and in the language background of each child. The pupil learns to read the words which he finds necessary for him to use in writing. One of the major instructional tasks in this method is to engender a stimulating language environment [Dykstra, 1967 VII].

Three programs having language-experience as their major emphasis are Macmillan Company's The Bank Street Readers, Chandler Publishing Company's The Chandler Reading Program (whose texts are entitled The Chandler Language-Experience Readers), and Mae Carden, Inc.'s The Carden Method.

PHONIC WORD METHOD

A reading program whose vocabulary is controlled for spelling regularity, but which otherwise differs little from traditional basal readers, is Daniels and Diack's (1959 V) Phonic Word Method, with its Royal Road Readers. Unlike the authors of the basal reading programs and the Language Experience programs, Daniels and Diack did attempt to have an empirical base for at least part of their Phonic Word Method. They conducted perception studies to show that children visually analyze whole words into letters and letter groups (Daniels and Diack, 1956, 1959; Diack, 1960). From their experimental evidence that letters within words (not isolated letters or whole words) are the meaningful units in reading, and from their theory that reading instruction must involve teaching the meaning of letters, Daniels and Diack developed their program. The Phonic Word Method is not a synthetic phonics program (sounds are not isolated and blended into whole words). Instead, by reading regularly-spelled words in context, the child is expected to induce the relationship between sounds and letters. Thus, visual rather than aural analysis is endorsed. Few phonics rules are verbalized. It is through a process of visual analysis and substitution that the child learns what letters "mean."

Given below are the more important points of Daniels and Diack's (1959, V) general description of their Phonic Word Method program:

> 1) The principle of vocabulary selection by difference of word-shape or configuration is rejected....
>
> 2) In addition to the principle that the words must be within the child's normal vocabulary, vocabulary control is on the principle of graded phonic complexity. That is to say, the number of different letter-meanings (Grapheme-phoneme correspondences) is rigidly controlled, not only in each book, but also on each page....
>
> 3) Great attention is paid throughout to the relationship between visual and aural analysis....
>
> 4) Though phonically based, this is not the traditional phonic method but a method in its own right, for three reasons:
>
> > a) Firstly, in the phonic word method, the child starts with whole words in meaningful picture-contexts. These words are chosen to give the pupil the kind of practice in visual discrimination that will be useful to him at all later stages.
> >
> > b) Secondly, letter-meanings are taught functionally in words so as to avoid the intrusive vowels of the old-fashioned "kuh-a-tuh" for cat....
> >
> > c) Thirdly, in the Readers, the grading is so carefully controlled that on no page is the pupil required to solve a reading 'problem' which he has not, on some teaching page, been given the means and techniques for solving. This ensures a continual practice in attack upon new words that are still within his scope [however, there are few verbalized phonics rules]. At the same time, the child is constantly acquiring greater familiarity with many common words which he comes to recognize in the 'differentiated whole' manner of the experienced reader--with a consequent increase in fluency.
>
> 5) The method insists upon pupils' self-activity. Any newly-acquired skills are immediately brought into active use.

LIPPINCOTT SERIES

The Lippincott reading series (McCracken & Walcutt, 1966 III) also selects vocabulary words on a phonic-regularity principle, but it utilizes a synthetic phonic approach. In the Lippincott Preprimer, Primer, and Books 1-1, 1-2, and 2-1 the lessons center around the presentation of phonic elements and lists of words employing these elements. This material is followed by a few sentences, a poem, or a story. The authors of the series claim that, with the exception of a few irregularly-spelled words which are pointed out to the reader, every story or poem contains only the letter-sounds that have been taught at any point. However, the stories do often use consonant clusters after their component sounds have been taught, but before there has been any instruction on these clusters as units. The child is expected steadily to accumulate new words in his reading vocabulary by recognizing letter-sounds in words. Basically, the instructions for this procedure are:

> We first demonstrate to the child how the two letter-sounds of a and m are brought together to make the word am. Thereafter, with every letter taught we make new words; but instead of asking the child to gasp the letters together into a word, we consistently show him how the letter-sounds appear in the new words. Having taught a, n, and then r, we demonstrate r-a-n ...ran by showing how the sounds appear in the word. To put it another way, we teach the words as wholes while we lead the child to see how the sounds that he knows appear in each word and are systematically represented by the letters in it [McCracken & Walcutt, 1964 III].

In Book 2-2 and thereafter, a "Phonics Guide" appears at the end, giving letters or letter-groups with whole word examples of their pronunciations (e.g., b: boy, ball, rabbit, web...; oa: oar, oath, road...; ile as short il: futile, fertile, missile...).

The child receives considerable practice in writing new letters. He listens for and says words beginning with new sounds, writes from dictation new words containing the new elements learned, and reads the words out loud. But the child also has to give the meanings of new words, or at least use them in context. There is a high vocabulary load in the Lippincott series. Whereas there are only about two new words per 100 words of text in the Ginn and the Scott, Foresman series, there are about 37 per 100 in Lippincott's due to the lists of words containing the phonic elements taught in the lessons.

> If learning language is learning the meanings of sounds (i.e., words), learning to read is

> learning letter meanings, for the entire system of alphabetic writing is based on the use of letters to indicate individual sounds. English spelling seems very imperfect when we look at the strange words like might, cough, should, colonel, sleigh, and machine; and indeed it is needlessly bad, for we use 26 letters or spell 44 basic sounds in more than 250 different ways. That is one side of the matter; but if we look at all the words that are spelled regularly, and then set about organizing the irregular spellings into groups and patterns, we find that it is not so bad after all. And if we begin with the regular system, it is not at all difficult ot master the exceptions when they are taken one at a time [McCracken & Walcutt, 1964 III].

The methods of guiding the pupil's reading and the type of follow-up activities in this program do not differ greatly from the conventional basals.

OPEN COURT SERIES

The Open Court Basic Readers (Trace et al, 1967 III) is a series which differs more from the basals than the Lippincott series. The Open Court program is similar to the Lippincott program except that there is more emphasis on writing, letters, spelling, and blending sounds into words. Blending skills are taught systematically, commencing with the first lesson. As each new sound is introduced, the child hears it, says it, sees it, and writes it. The progression in each lesson, for both reading and writing, is from sound to word to sentence. By the middle of the first grade, the child has practiced the 43 sounds that Open Court considers basic to English, sequentially introduced in this program. Up to this point, the vocabulary is consistently phonic so that the child can routinely sound out words which he does not recognize. In the second half of the first grade, however, irregular spelling patterns are introduced and the vocabulary is no longer strictly phonic. A final interesting aspect of the Open Court program is that:

> Proofreading is taught from the early days of school so that the children learn to take responsibility for correcting their own work. The child's written work enables him to see and to evaluate his own progress in reading, in spelling, in penmanship, and in the writing of original sentences [Trace et al, 1966 III].

O. K. MOORE

The most unconventional reading program to be reviewed is Omar K. Moore's, which utilizes automated and manual typewriters. Moore advocates that reading instruction should begin when a child is two or three, when he "is still free to explore, when learning is a 'game', and when he is not upset by success of failure [Moore, 1963 VI]." The primary motivation, according to Moore, should spring from the child's natural curiosity and desire to learn to read. The child's reward comes from his own discoveries and achievements.

Moore separates the reading process into stages, the first being the acquisition of the code, or the alphabetic principle. Later the stress is on interpretation, application, and appreciation. "Essentially, the major task in beginning reading is learning to recognize words. The first grader already knows the meanings of the words he reads; therefore, meaning is really not the instructional problem [Moore, 1963 VI]." Basal reader proponents feel the change from beginning to "mature" reading comes in grade two or three for most children, and at grade four for others. Moore and the linguistic group say the change can come earlier--at the end of first grade for the average pupil and at the end of second grade for the slower one (Chall, 1967 VII).

Moore believes that the acquisition of reading skills should parallel the acquisition of oral language. He designed an instructional procedure to reinforce the child for spelling and reading words in the same manner that parents reinforce the child for his first words. When a child starts the Moore program, he is allowed to explore an automated typewriter. As he strikes a key, the typewriter calls out the name of the letter or symbol struck. This continues until the child learns the names of the letters, numbers, and punctuation symbols. Then he is taken through a series of steps in which a letter, number, or symbol is presented to him on a screen and he reproduces it on the typewriter. The child begins by learning letters, and then proceeds to words and sentences. Grapheme-phoneme relationships are not taught directly, although the child is given heuristic hints. Instead, the child spells out new words, using letter names rather than letter sounds. Letter names are also used as a means of recall and word attack. There is an attempt to control the difficulty of spelling patterns in the child's beginning reading vocabulary, but Moore also uses any materials the child is interested in (e.g., word lists, conventional basal series, storybooks, and graded exercises). The child is taught to write words and sentences as well as read and type them. His program also contains a speaking, listening, and writing-from-dictation sequence.

BLOOMFIELD

Another proponent of the alphabetic principle (perhaps its best known expositor) is Leonard Bloomfield, who stressed the alphabetic principle in defining reading as the act of transforming graphemes into sounds (Bloomfield, 1942a, 1942b, IV). Bloomfield's approach opposed an initial emphasis on meaning. His thesis was the utilization of the child's vocabulary through instruction in decoding printed equivalents to oral vocabulary. Inherent in this system is the assumption that linguistics is based upon spoken language (which is governed by orderly rules) and that the orthographic system is considered only an imperfect reflection of spoken language. Bloomfield's reading program, in effect, attempts to compensate for this imperfect fit. In addition to his opposition to meaning, Bloomfield also disavowed the use of phonics, sight-word learning, sounding, blending, context clues, and pictures. To replace the foregoing techniques, Bloomfield proposed the "discovery" of letter-sound relationships from regularly-spelled words. To this end he formulated a reading acquisition program with the following characteristics:

1) Children should learn the alphabet before reading instruction is begun.

2) A one sound-one symbol correspondence is employed.

3) Regularly-spelled words are taught first and are sequenced in ascending order of difficulty.

4) Words are always read as wholes. Bloomfield cautions against phonic methods that utilize isolated sounds:

> The authors of these methods tell us to show the child a letter, for instance t, and to make him react by uttering the t-sound; that is, the English speech sound which occurs at the beginning of a word like two or ten. This sound is to be uttered either all by itself or else with an obscure vowel sound after it. Now, English-speaking people, children or adults, are not accustomed to making that kind of noise. The phoneme /t/ does not occur alone in English utterance; neither does the phoneme /t/ followed by an obscure vowel sound. If we insist on making the child perform unaccustomed feats with his vocal organs, we are bound to confuse his response to the printed signs. In any language, most phonemes do not occur by themselves, in isolated utterance, and even most of the successions of phonemes which one could theoretically devise, are never so uttered. English speakers do not separately pronounce the sound of /t/ or /p/ or of /u/ as in put, and a succession like [sp], for instance, as in spin, does not occur alone, as a separate utterance. Learning to pronounce such things is something in the nature of a stunt, and has nothing to do with learning to read. We must not complicate our task by unusual demands on

> the child's power of pronouncing. We intend to apply phonetics to our reading instruction; this does not mean that we are going to try to teach phonetics to young children. In this absurdity lies the greatest fault of the so-called phonic methods [Bloomfield & Barnhart, 1961 IV].

5) Oral reading should be stressed in the beginning sequences of reading instruction.

6) When a new word is taught or missed, the child should spell it rather than sound it.

7) Each correspondence should be learned before the next is introduced.

This short review of Bloomfield's system serves to outline his position. A discussion of the relative merits of this system will be deferred in order to present reviews of the contributions to reading theory of two other linguists.

FRIES

Fries, having a background in English and Linguistics, has designed a reading instructional system based, to a large extent, on an alphabetic system similar in many ways to Bloomfield's:

> The recognition responses to be developed in the reader of the transfer stage are those of spelling-patterns consisting of sequences of letters of the present-day English alphabet. It is alphabetic writing. Inasmuch as the graphic shapes which constitute our numerals (both Arabic and Roman) are not _alphabetic writing_ but logographic or 'word' writing, the 'reading' of all numerals is postponed until after _the principle of our alphabetic writing has been fully grasped_ [Fries, 1963 IV].

This system of instruction is divided into three stages: the "transfer" stage, the stage of "productive" reading, and the stage of "vivid, imaginative realization":

> The first stage has been given the name _the transfer stage_ in order to stress as heavily as possible the one single and simple distinguishing feature of the reading process. Learning to read in one's native language is learning to shift, to transfer, from auditory signs for the language signals, which the child has already learned, to visual or graphic signs for the same signals. Both reading and talking have the same

> set of language signals for language *reception*. In talking, contrastive bundles of sound features represent these signals; in reading, contrastive patterns of spelling represent these same signals. For *language reception through talk*, the child of four has developed, by means of more than 5,000 hours of *practice*, great skill in making high-speed recognition responses to the patterns of sound features that represent the language signals; *for a similar language reception through reading* the child needs to develop, by means of from one tenth to one fifth as many hours of practice, a similar but new skill in making high-speed recognition responses to the spelling-patterns that also represent the same language signals [Fries, 1963 IV].

Characteristics of Fries' transfer stage program are as follows:

1) It is concerned with reading only, not writing.

2) It is not concerned with productive spelling habits.

3) The first set of recognition responses to be developed are for the alphabet.

4) Letters must be identified as contrasting shapes.

5) Identification must be practiced until the child's recognition responses to the significant features that separate each letter become automatic.

6) "Unadorned" capital letters should be presented initially.

7) Two or more letters should be presented concurrently in order to permit contrast.

8) The introduction of each new item should provide the occasion for a review of all those previously practiced.

9) The children must learn high speed responses to groups of letters as well as to individual letters.

10) The learning of letter names is not necessary during the initial stages of instruction.

11) There should be no attempt to relate letters to their sounds.

12) After responses to letters and letter-groups become automatic, children must learn to respond to spelling patterns.

13) "The major sets of spelling-patterns which constitute the substantive body of material to which beginning readers must develop high speed recognition responses, are best organized for the necessary practices in accord with the contrastive letter sequences that identify each of the various kinds of vowel phonemes [Fries, 1963, IV]."

14) The substantive material is programmed into a progression of small, coherent strips through the major patterns.

15) The words and meanings used are within the actual linguistic experience of the children.

16) Only complete words are pronounced.

Fries' word attack instruction is contained entirely within the Transfer Stage.

The other two stages, the stage of "Productive Reading" and the stage of "Vivid Imaginative Realization", will be mentioned to provide continuity for the reader:

> The next, the second stage, covers the period during which the reader's responses to the visual patterns, the bundles of graphic shapes, become habits so automatic that the significant identifying features of the graphic shapes themselves sink below the threshold of conscious attention. He seems to respond to the meanings that are signalled without the use of signals themselves. Finally, the cumulative comprehension of the meanings become so complete that as reader he can as he goes along supply those portions of the language signals which the bundles of spelling-patterns alone do not represent [Fries, 1963 IV].

The last stage in developing the ability to read, the stage of "Vivid Imaginative Realization" begins:

> When the reading process has become so automatic for the reader that he uses reading equally with or even more fully than the live language of speech in acquiring and assimilating new experience. Reading at this level stimulates a vivid imagination realization of vicarious experience. Reading responses of this kind fulfill the 'literary' purpose....
>
> The literary purpose is, I believe, the use of language to communicate not facts and information but vivid imaginative realizations of actions, of emotions, of values. The literary artist carries a capacity for vivid impressions into every part of man's experience, and then we share the sensitiveness of his keener insight through his power to communicate vivid realizations of his experience [Fries, 1963 IV].

LEFEVRE

Carl Lefevre (1964a, 1964b IV) is the third linguist whose contributions to reading theory are considered in this section. He differs markedly from Bloomfield and Fries in that he emphasized reading for comprehension at the outset of instruction. Lefevre's theory of reading is summarized in fourteen points--some of the more important are:

1) Reading is basically a language-related process.
2) a) Language is speech, an arbitrary code or system of vocal symbols. It is non-instinctive behavior; it must be learned.
    b) Graphic symbols of writing and print comprise a secondary, derivative system.
    c) Thus, two interrelated symbol systems interact, the manual-visual with the audio-lingual....
3) Children should learn to read and write the language they already speak and understand....
4) Developing literacy in the native language should proceed on the analogy of learning native speech as infant and child....
5) Efficient reading requires consciousness of the relative equivalency of the graphic counterparts to spoken language structures.
6) Accordingly, some reading problems can be solved by developing consciousness of pertinent language processes and their interrelationships with graphics. This statement applies especially to the relationship of written and printed symbols to their equivalent speech segments.
7) The sentence is not merely a sequence of words, but a unitary meaning-bearing pattern of grammatical and syntactical functions; the individual words are relatively minor elements in such unitary patterns.
8) a) Individual words have less significance to hearer or reader than is commonly attributed to them.
    b) The significant elements are grammatical and syntactical structures; noun and verb groups and clusters, clauses, sentences....
9) The child learning to read should practice reading entire meaning-bearing language patterns at the sentence level.
10) Mastering the graphic system by giving his main attention to larger patterns, a learner would develop his own inductive generalizations or sound-spelling relationships (and this largely through his writing); in reading he would need formal spelling instruction only to get him over difficulties.
11) The American English sentence should be read not as a sequence of words but as a unitary meaning-bearing sequence of sturctural functions clearly signaled and patterned by intonation, syntactical functions in basic sentence patterns,

> structure words, and word-form changes....
> [Lefevre, 1964a IV].

LINGUISTIC PROGRAMS: COMPARISON

Although linguistic approaches to reading are at variance over many issues, there are several commonalities among them. The linguistic programs mentioned thus far agree that oral reading is more efficacious in the initial stages of reading instruction and that graphic symbols do represent spoken language (Bartkowiak, 1967 IV). They further agree that since reading is a language-related process, its instruction should capitalize on children's knowledge of their language. This might seem obvious; however, a study of children's oral language revealed that children's syntax is more complex than that used in most basal readers (Strickland, 1962 IV).

The linguistic programs differ in several ways: Bloomfield and Fries stressed an initial reading mechanics approach excluding meaning, while Lefevre says that meaning must be included during the initial stages of reading. Lefevre uses an argument for not presenting individual words that parallels Bloomfield's argument for not presenting isolated letter-sounds. A single word rarely offers knowledge of supersegmental features necessary for proper pronunciation. For example, the word contract is classified both as a noun and a verb. How, Lefevre asks, does the student know whether to stress the first or second syllable when the word is presented in isolation (Strickland, 1962 IV)? Furthermore, Lefevre strongly criticizes Bloomfield's artificial sentence constructions:

> The main objection to the Bloomfield spelling-reading lessons is the rigid insistence throughout on the spelling and sounding of words in artificial sentences, made up at best of foreign-sounding word groups, and carrying strange rhythms and tunes. If used as prescribed, this method and these lessons might easily contribute further to that word-by-word reading that already characterizes many of our worst reading cripples, both in school and in later life [Lefevre, 1964 IV].

Bloomfield and Fries sequence their stimulus material from small to large units, (e.g., letter patterns to words to sentences) and from simple to complex units (e.g., regular to irregular spelling patterns). Lefevre takes an antithetical position beginning with larger, more complex units (i.e., meaningful sentences).

Letter sounds are "discovered" rather than explicitly taught in all three systems. Bloomfield and Fries place great emphasis on this code-reading activity. Lefevre de-emphasizes it, stressing comprehension.

Bloomfield, Fries and Lefevre represent the initial thrust of linguistic applications to reading. Their influence in the field of reading has been widespread but their acceptance has been ambivalent. Some educators have criticized their attempts at formulating instructional procedures based on their theories (Goodman, 1964; Durkin, 1963; Heilman, 1963 IV). Others have lauded their attempts, advising teachers of reading to adhere to these and other linguistic programs (Rystrom, 1965; Strickland, 1964; Creswell & McDavid, 1963; Markman, 1963 IV).

It is our contention that these traditional linguistic theories of reading are valuable because they helped establish reading as a larger, interdisciplinary field. Criticism of these theories extends beyond those mentioned above. According to more current views of language, they are far too simplistic in coverage (Francis, 1963; Chomsky & Miller, 1963; Venezky, 1967; Chomsky & Halle, unpublished IV). Furthermore, these three theories prescribe pedagogical methods for which no supporting data is presented. At best, they can only be regarded as possible hypotheses.

i.t.a.

Bloomfield's reading theory and the Initial Teaching Alphabet i.t.a. share the underlying assumption that the relationship between the spoken language and the orthography should be closer than it is in the present system. The formulation of (i.t.a.) is credited to Pitman (1965 VI), and was further developed in England by Downing (1962, 1963, 1967 VI). The position of i.t.a. adherents on the nature of reading in language is stated by Mazurkiewicz:

> The reference to the inconsistencies in spelling the English language is understandable when it is recognized that English is about 11 per cent phonetic. Assuming as a standard the American College Dictionary, the 44 phonemes of English are represented by 251 different spellings; other sources differ. It has been recognized that there are many irregularities in the relationship between sound and symbol in English. Almost every phonic rule that children can be taught, or led to discover, has exceptions. This makes the teaching and learning of English phonics considerably more difficult than it would be if each letter represented just one sound, as is true, or almost true, of several European languages. The recent controversies over look-say versus phonic teaching as the cause for reading retardation are therefore recognized to have been worthless and misleading--particularly so in a language which has not learned to spell yet [Mazurkiewicz, 1966 VI].

Pitman recognized that a permanent spelling reform was infeasible; therefore, he designed the i.t.a. as a simplified, consistent, beginning reading code. The i.t.a. alphabet contains forty-four symbols instead of the traditional twenty-six. Twenty-four of the symbols are the same as those used in the traditional alphabet, fourteen of the new letters look like two traditional letters combined, and the remainder resemble some form of the traditional alphabet. Only lower case characters are used; capitals are simply a larger type size of the lowercase form.

Letter sounds, rather than letter names, are taught. In general, one symbol is used to represent one sound, thereby making possible a more consistent phonic analysis of words. However, i.t.a. should not be considered a phonic method. In fact, its developers advocate no one teaching method. "i.t.a. should be regarded as a writing-system which is available for teaching by any methodology [Downing, 1967 VI]." There are departures in i.t.a. from a one-symbol-to-one-sound relationship, but these departures were made deliberately in order to make i.t.a. orthography look more like the traditional orthography (t.o.) which the child later sees. Pitman had envisaged an easy transition for children from i.t.a. to t.o. Unfortunately, a significant amount of negative transfer has occurred. Downing (1967b, VII) now speaks of the "plateau or even regression in the growth of (reading and spelling) skills at the stage of transition from i.t.a. and t.o." Gillooly (1966 VII), in reviews of studies comparing i.t.a. to t.o. approaches, concludes that at the end of the first grade there is no significant difference between the two in word recognition, reading comprehension, paragraph meaning, vocabulary, or word attack skills. The tests were given in t.o. On spelling tests, however, t.o.-trained children did significantly better (in t.o.) than the i.t.a.-trained children. Fry (1966 VII) found, though, that when i.t.a. spelling was scored as correct, there was no significant difference between the groups. Dykstra (1967 VII), in his compilation of studies, found that at the end of the second grade, i.t.a.-trained students spelled significantly better than the t.o.-trained students. They also ranked higher on word recognition, although there were still no significant differences in the other reading skills. Thus, the transfer effects of i.t.a. may be transient. On the other hand, the higher scores may be due to whatever instructional method was used in the second grade, rather than the i.t.a. training in the first grade. Downing feels that having the transition stage at the end of the first grade is premature, and that it would be beneficial for American programs to follow the British example of having the transfer made at the end of the second grade or the beginning of the third. But, he admits, attempts must now be made to reduce the loss at the transition stage, at whatever grade level it occurs:

> Despite the i.t.a.'s success, both before and after transition to t.o., there is clearly room for improvement on i.t.a's present design. It may even be necessary to evolve a new s.r.w.s. (Simplified and regularized writing-system)

> which will eventually supplant i.t.a. What is needed now is a series of experiments to ensure that every element in whatever s.r.w.s. is adopted has been established empirically as the best possible solution in the total complex of problems involved in making the needs of the beginner compatible with maximal transfer efficiency at the later stage [Downing, 1967 VII].

SILBERMAN

The last reading program reviewed in this section is an empirically-based phonics program (Silberman, 1964b V). It embodies a set of procedures associated with operant conditioning and its applications to programmed instruction. Silberman initially conducted a literature search in the areas of reading and verbal learning (Silberman, 1963b V). Based on the results of this review, site visits to local schools and consultations with several reading teachers, an initial program was formulated. The program objectives consist of blending the initial consonants and VC syllables marked in the cells of the matrix in Figure 2.

Trigram Endings

	an	it	at	in
f			x	
r				x
s				x
m		x		
p			x	
b	x			

Fig. 2. Consonant-by-VC syllable matrix

(Silberman, 1964b, V)

The unmarked cells were used in the instructional sequences. Once the initial program was formulated it was tested and modified, using individual children:

> A tutorial procedure was used to determine what changes should be made to the program. The program was tried with one child at a time. If, in the judgment of the experimenter, the child was making a sufficient number of errors. to warrant assistance, his progress through the program was halted so that the cause of his difficulty could be ascertained. Then the experimenter attempted to remedy the

> difficulty by a variety of tutorial techniques. When the child resolved his difficulty, the experimenter recorded the program variation that seemed effective. This process of tutorial modification was continued until a sufficient number of tutorial changes were recorded to warrant a major revision to the program. The revised version of the program was then given to other children and a second revision to the program was made. Subsequent revisions were made in the same manner [Silberman, 1964b V].

There were thirteen revision cycles over the duration of program development. Each revision was programmatic, but unsystematic and atheoretical.

The scope of the program is limited to phonics. One of the most interesting findings in Silberman's study was that children do not necessarily induce letter-sound relationships upon being exposed to whole words (Silberman, 1964b V).

COMPARISON OF METHODS

Most of the reading programs discussed thus far have been formulated and implemented without an empirical base. Conceptualization of much of the subject matter(particularly the word attack aspect) has not been explicit. Hypotheses concerning instructional procedures have not been empirically tested and revised. Instead, reading program designers have tended to establish themselves or their consultants as reading instruction experts whose pedagogical hypotheses are implemented and dogmatically expounded as fact. It is possible that a substantial number of these hypotheses are valid. However, they are amenable to empirical investigation and should not be accepted or discarded until well-designed experiments have been conducted.

Numerous studies have been devoted to a comparison of reading instruction methods. The majority, however, have been isolated and uncoordinated, with each considering only two or three methods. Furthermore, the research has been conducted by independent investigators who have used different criteria and tests of entry skills (reading readiness) and terminal skills (post-instructional). Substantial variation is also found in the experimental populations, research designs, methods of statistical analysis, length of instruction, materials, and in the extent to which investigators have assessed and/or controlled such factors as experiential background of the children, class size, teacher competence, degree to which the instruction is structured, and a "Hawthorne effect". In addition, the experiments have not been described in adequate-enough detail to allow replication or comparison. (Bond, 1966 VII)

Three comparative research studies attempted rigorous investigations of pre-package programs: Bliesmer and Yarborough's "Comparison of Ten Different Beginning Reading Programs in First Grade [1965, VII]," Ruddell's "Reading Instruction in First Grade with Varying Emphasis on the Regularity of Grapheme-Phoneme Correspondences and the Relation of Language Structure to Meaning [1965a, 1965b, 1966 VII]," and Dykstra's "Cooperative Research Program in First-Grade Reading Instruction [1967a, 1967b, 1968 VII]."

Bliesmer and Yarborough compared the relative effectiveness of ten commercial programs for first grade reading instruction. The ten programs, although differing in instructional materials, procedures, and sequencing, could be divided into two basic instructional approaches: 1) the analytic method, "based upon the belief that the child should be taught whole words and then, through various analytic techniques, recognition of letters and the sounds they represent, and the synthetic method, "based upon the belief that the child should be taught certain letter-sound relationships or word elements before beginning to read and then be taught to synthesize word elements learned into whole words [Bliesmer & Yarborough, 1965 VII]." Of the five programs considered to represent the analytic method, three are basal reading series (ABC Betts Basic Readers, 1963; Ginn, 1959; and Scott, Foresman, 1962 III). The other two were individualized reading programs, one being supplemented with the Science Research Associates Reading Program, the other using no specific set of commercial materials.

Of the five programs utilizing a synthetic approach, one is a conventional basal reader program (Houghton Mifflin, 1963 III), and one is a more phonically-oriented basal series (Lippincott, 1963 III). The remaining three are Economy Company's Phonetic Keys to Reading (1953 III), McGraw-Hill's Programmed Reading (1963 III), and Singer's Structural Reading Series (1963 III).

The 484 subjects were given post-instructional tests on word reading, paragraph meaning, vocabulary, spelling, and word study skills. The data revealed that when the means of the analytic program groups are compared with those of the synthetic program groups, a great preponderance of differences among means (92 out of 125, or 74%) is found to be significantly in favor of the synthetic group [Bliesmer & Yarborough, 1965]." The analytic group did not score significantly higher on any of the tests. Even on the comprehension skills test, for which other studies have found either a difference favoring an analytic approach or no significant differences, the synthetic groups scored significantly higher on 20 out of 25 comparisons. The other five differences among means are not significant.

In the synthetic program groups, there were numerous significant differences favoring Houghton Mifflin, Lippincott, and Singer over Economy and McGraw Hill. However, only one out of 15 comparisons between the first three is significant. The differences among the criterion measure of the five analytic approaches is significant in only six out of fifty instances; and these six all favor the individualized approach. Bliesmer and Yarborough conclude that "the order of instruction of letter sound elements and/or relationships may not be as important in the success of synthetic programs as that the number of letter-sound relationships taught be sufficient to equip pupils with means for independent decoding of words." Also, "it would seem...that methodology, rather than specific programs or materials used, is the more decisive factor in the overall effectiveness of reading instruction in grade one [1965 VII]." Bliesmer and Yarborough's results, however, are suspect because they do not, at any point in this paper, disclose the type of statistical evaluational techniques employed in their study. Only significance or non-significance of comparisons are disclosed.

Ruddell's "Reading Instruction in First Grade with Varying Emphasis on the Regularity of Grapheme-Phoneme Correspondences [1965a, 1965b, 1966 VII]" is the best-controlled of the three studies reviewed. He compared four approaches of reading:

1) In the first (Program B), grapheme-phoneme regularities were not controlled in the vocabulary. The emphasis on phonic training in establishing grapheme-phoneme correspondences was initiated at the primer level, and the early stages of phonic training dealt with initial consonant correspondences. No specific emphasis on language structure as related to meaning was provided. The teacher's manual, basal reader, and workbook of Allyn and Bacon's Sheldon's Basic Reading Series (1957 III) were used.

2) The second approach (Program B+) was the same as Program B except that it included the following supplementary work: an emphasis in the initial stage was placed on intonation patterns as related to meaning and written punctuation; several basic patterns of language structure were developed; and the relationship of words and word groups to meaning contrasts in each pattern were stressed. Contrasting meaning changes included word substitution, pattern expansion and elaboration, pattern inversion, and pattern transformation to a question.

3) In the third approach (Program P), the grapheme-phoneme regularities were controlled and programmed. The emphasis on phonic training in establishing grapheme-phoneme correspondences was initiated in the prereading material, and the initial stages of phonic training dealt with the short a, the schwa, and four initial consonant sounds. No specific emphasis on language structure as related to meaning was provided. The teacher's manual and programmed basal reading materials of McGraw-Hill's Programmed Reading (1963 III) were used.

4) The fourth approach (Program P+) was the same as Program P except that it also included the supplementary work found in Program B+.

Criterion tests were administered to the 24 classrooms to evaluate reading achievement in word reading, word study skills, paragraph meaning, vocabulary, oral reading of regular and irregular words, syntax, and morphology. An analysis of covariance was conducted and t-test compared the adjusted means. The covariate of each criterion variable consisted of the readiness variable that was found to correlate most highly with the dependent variable under consideration.

In the results section of Ruddell's reports, there are some discrepancies between his tables and comments. Several of these may be due to typographical errors (e.g., more than once, two programs are said to have a significant difference in means, but this significance is not indicated in the tables). Other statements are more suspect. For example, at one point Ruddell (1965b) states that nonsignificant results were obtained for the contrasts between Programs P, P+, B, and B+ on irregular word identification tasks. His accompanying table indicated likewise. However, in the summary section (and in the 1966 report) Ruddell concluded that Program P+ scored significantly higher than Program B+ on this test. With these discrepancies in mind, the following results are presented:

1) Programs P and P+ showed significantly higher word reading, word study skills, and regualr word identification scores than Programs B or B+, with one exception: there was a nonsignificant mean difference on the word study skills test between Programs B and P.

2) Program P+ showed significantly higher irregular word identification scores than Program B+. There was a nonsignificant mean difference between Programs P and B.

3) Program P+ showed significantly higher paragraph meaning and sentence meaning scores than P. Programs B+ and B were not significantly different.

4) Scores from tests of morphology and syntax at the beginning of first grade had a significant correlation with scores on paragraph meaning, sentence meaning, and vocabualry tests. Ruddell (1965a, 1965b VII) concludes that the latter are, therefore, a function of the former: "the control which the subjects exhibit over designated aspects of their morphological language system and their syntactical language system." If, by "function", he is implying a cause-effect relationship, this conclusion is not permissible from the measures used.

Dykstra (1966a, 1966b, 1967 VII) directed the coordination of 27 first grade reading instruction studies. Fifteen of these projects were continued through the second grade. The results of the second year investigation are reported here. Correlations were assessed between performance on reading readiness tests administered at the beginning of first grade and achievement at the end of second grade on the Stanford Achievement Test, and between measures of first grade achievement and second grade achievement. All correlations were expressed in terms of Pearson product-moment correlation coefficients. Correlations among the various scores were computed separately for each of the five program categories--Basal, i.t.a., Language Experience, Linguistic, and Phonic/Linguistic. Correlation coefficients were calculated by pooling within sex, within class, and within project. The Basal programs were then compared in effectiveness with each of the other four categories.

The findings relevant to this paper are summarized as follows:

1) The correlations of readiness measures with second grade word recognition are:
    a) Knowledge of letter names (The Murphy-Durrell Letter Names Test): .41-.52. The correlation was somewhat larger at the end of first grade.
    b) Discrimination of like and unlike beginning and ending consonants (The Murphy-Durrell Phonemes Test): .38-.49.
    c) Intelligence, as measured by the Pintner-Cunningham Primary Test: .32-.50.
2) Readiness measures as correlated with second grade reading comprehension are:
    a) Knowledge of letter names: .45-.53.
    b) Intelligence: .40-.60.
    c) Discrimination of like and unlike sounds: .40-.52.
3) Correlations of the readiness measures (letter name knowledge, intelligence and sound discrimination) with spelling, language and word study skills ranged from .40-.55.
4) Most of the correlations between first and second grade reading achievement were greater than .60.
5) Correlations were substantial among all of the second grade measures of achievement. For example, correlated with word recognition were:
    a) Comprehension: .75-.81.
    b) Spelling: .60-.73.
    c) Word study skills: .57-.71.

The pertinent conclusions drawn by Dykstra in regard to these results were:

1) Ability grouping in second grade reading can be done with greater validity on the basis of first grade reading scores than on information about a pupil's readiness for reading at the beginning of first grade. This lends support to the principle that the best predictor of success in a learning task is prior success with a similar task.

2) Measures of letter knowledge, auditory discrimination, and intelligence were most highly related to second grade achievement in all treatments. The predictive validity of each of these measures is substantially the same as that obtained by an entire readiness battery test. So, if the prediction of reading success is the sole criterion, a single subtest such as the letter names test would be just as effective.

3) Letter knowledge, auditory discrimination, and intelligence were related to spelling, reading, and language ability to essentially the same degree at the end of second grade. Of course, there is not necessarily a cause and effect relationship. All these abilities may be related to a third factor such as home background (Dykstra, 1967a VII).

After studying within-program variables, Dykstra made between-program comparisons.

> Not all treatments were represented in all projects, and as a result, it was not feasible to make direct comparisons between such treatments as i.t.a. and Linguistic, Language Experience and Phonic/Linguistics, or any other combination of innovative programs. The extreme project differences in achievement would have made comparisons between treatments found in different projects meaningless. As a result, it was possible only to compare the various innovative treatments with the basal treatment in each project [Dykstra, 1967a VII]:

1) Basal vs. Language Experience: No significant differences were found in reading, spelling, or general language ability tests.

2) Basal vs. Linguistic: There was no significant difference in reading comprehension. Basal programs were superior in word study skills, but Linguistic programs were slightly superior in spelling and word recognition.

3) Basal vs. Phonic/Linguistic: There were only two such projects. Both had the Lippincott series (1966, III) for the Phonic/Linguistic program, and this series scored higher than the basal series in reading, spelling, and general language ability.

4) Basal vs. i.t.a.: No significant difference was found in reading comprehension, rate of reading, English usage, or mechanics of punctuation. The i.t.a. program was superior in word recognition skills, word meaning, discrimination of like and unlike sounds, and spelling. "It appears that the use of a regular code for initial instruction in reading produces better than average ability to decode the printed word and encode the spoken language [Dykstra, 1967a VII]."

One of Dykstra's comments in regard to the results of the word recognition tests was that the teaching of phonics appears to be highly related to word recognition at the end of second grade, even though the phonics was taught in a variety of ways. In the i.t.a. programs of Downing and Mazurkiewicz, for example, pupils are first taught symbols, then the sounds associated with them, and then how to use this knowledge in decoding words. The Linguistic programs, on the other hand, encourage pupils to discover the letters which represent certain sounds--there is no attempt to blend sounds into words. The Language Experience programs do not emphasize phonics either; they, too, were surpassed in word recognition by Phonic/Linguistic programs.

Apparently, various kinds of control of grapheme-phoneme correspondences help the child to recognize more words at an earlier stage. Linguistic, Phonic/Linguistic, and i.t.a. programs were all superior in word recognition and spelling. "Control of vocabulary, either by a transitional alphabet or by introducing initially only regularly represented words, appears to facilitate acquisition of skill in unlocking words and in spelling [Dykstra, 1967a VII]." Dykstra questions whether the programs are superior because of characteristics of the total program or because of such individual elements as heavy phonics emphasis, introduction of a large vocabulary, use of a consistent alphabetic code, or utilization of a writing component. His resolution is that they may be superior simply because they introduce a larger number of words than the typical basal reader:

> The superiority of word recognition of pupils in various phonics emphasis programs is not, as a general rule, demonstrated in the area of reading comprehension. This finding would indicate that certain of these programs may not be concentrating as much on comprehension as a reading outcome as they are on word recognition. The assumption can also be made that ability to recognize words does not transfer automatically to ability to comprehend the meaning of sentences and paragraphs. This finding does not support the contention that the pupil's only task in learning to read is to develop the ability to translate graphemic symbols into sounds on the assumption that once he has decoded the words he will understand their meaning. Direct instruction in comprehension is apparently essential [Dykstra, 1967a VII].

Dykstra also concluded that pupils can learn to recognize more words than are commonly introduced in reading programs. Children today are probably better equipped for reading instruction when they enter the first grade. However, should the children learn more words? Longitudinal studies may show the importance of introducing vocabulary slowly and of repeating it often.

Projects appeared to have a greater influence on the reading ability of pupils than did the particular instructional method or materials utilized. Specific programs were relatively effective in one project, relatively ineffective in others. Yet, all programs used in the same project were found to be quite similar in effectiveness:

> This would indicate that the entire instructional setting is involved in the effectiveness of an instructional program in reading. Differences in method or materials alone do not alter, to any great extent, the reading growth of pupils .... Improvement of reading instruction is more likely to result from improved selection and training of teachers, from improved in-service training programs, and from improved school

> learning climates, rather than from changes in instructional materials [Dykstra, 1967a VII]."

The studies by Bliesmer and Yarborough (1965 VII), Ruddell (1965a, 1965b, 1966 VII), and Dykstra (1967a, 1967b, 1968 VII) represent the most comprehensive, best-controlled, program comparison investigations found in the literature. Program comparisons, however, prove unwieldy in that their results must be confined to the relative efficacy of one program over another. Based upon the results of 27 individual comparison studies, Dykstra made comparisons between categories of programs. His results must be interpreted cautiously because there was little control over the assignment of programs to groups and the combinations of techniques employed by each group. In some cases, there were greater intra-category differences than inter-category differences.

An even more important criticism of these studies is their lack of generalizability. Investigations that conduct program-specific research are limited in their discussions to those programs only. We express the need for more basic research which can be generalized to different reading approaches. The forthcoming section will elaborate on the literature relevant to our research program.

REVIEW OF CURRENT PHONIC AND WORD ATTACK RESEARCH

TRADITIONAL PHONIC GENERALIZATION RESEARCH

Moore (1951), Cordts (1954), Kottmeyer (1954), Black (1961), Fry (1963), Clymer (1964), Bailey (1967), and Burmeister (1967 V) have conducted studies based on the assumptions that phonic generalization rules should be utilized in reading instruction, that these rules can be ranked according to proportion of applicability, that rules should be taught in their rank order from highest to lowest, and that reading vocabulary and spelling words should be introduced on a regular-to-irregular continuum with respect to these rules. From their studies, Black and Fry also determined orders of introducing letter-sounds according to frequency counts of applicable phonics rules. Their orders were determined within classes (vowels, consonants, and blends) but not between classes.

Black presents her word count verification of 45 phonics rules formulated by Fry and four other counts (Moore, 1951; Cordts, 1954; Kottmeyer, 1954; & Fry, 1963). However, due to methodological differences, only general trends can be deduced from a comparison of these counts. For example, there was wide variation in the sources of word selection and samples ranged from 300 to 3,000 words. Different pronunciation standards were used; Black (1961), e.g., used her own individual pronunciation; there were also some differences in bases of tabulation. Black lists vowels and consonants alphabetically and gives each sound's frequency and percentage of occurrence in each of the five lists. It would have been more beneficial for her to have listed the sounds from high-to-low frequency and to have made direct comparisons between the word counts. Black rank-ordered the seven most frequent consonants and the seven most frequent vowels for each study, but, again, did not compare the results. For the most frequent consonants, all five studies had the same seven letters, with the exception of one, which had b rather than n. The five counts' mean rank ordering of the consonants was: /t/, /n/, /d/, /l/, /r/, /s/, /m/. For the vowels, all five studies rank /ɪ/, /e/, /æ/, as the three most frequent, and at least three of the studies had /y/, /ə/, and /schwa a/ ranked among the fourth-to-seventh.

Fry (1964 V) reviewed prior studies concerned with phonics rules, and concluded that: 1) The short vowel, and final e rules are borne out by the frequency counts; 2) rules about the schwa sound of reduced vowels is of relatively high importance; 3) there are only seven combinations for the long vowel digraph; 4) the r rule and the y rule, including that y has the long e (i) sound at the end of a word, are important; and 5) there are relatively few exceptions to these rules, and no others are worth teaching to beginning readers.

In his own study, based on his 300 "Instant Words", Fry gives the number of words adhering to each of his 45 phonic rules. But, he does not state the percentage of adherents vs. exceptions, nor the number of exceptions, nor a word frequency count (e.g. Thorndike-Lorge's or Rinsland's) of the exception words. Fry says that all but one (the Syllable Ending rule) of his 21 major and minor vowel and consonant rules are "good". However, at least one-half of his rules about vowels have below 70% utility according to Clymer's (1963 V) or Bailey's (1967 V) count. Clymer and Bailey included few rules concerning consonants.

Clymer (1963 V) selected 45 phonic generalization rules from four basal series' manuals. There were five principle types of rules: vowels, consonants, endings, syllabication, and miscellaneous relationships. These words were tested against the words in the four basal series (grades 1-3) plus Gates "Reading Vocabulary for the Primary Grades", for a total of 2600 words. The criterion was 75% utility (adherence). Clymer states that only 18 met the criteria, although there were six others above 75%. Other rules might have reached the criterion if they had been stated in more specific terms (e.g., including the immediate letter environment). Also, the validity of a 75% criterion should be determined. Once again, the word frequency of the exceptions to the rules was not taken into account.

Bailey (1967 V) tested Clymer's 45 phonic generalizations on eight basal series extending from the first through the sixth grade. A total of 5,773 words, each word appearing in at least two of the series, were used. Bailey concluded that of the 45 rules: 1) eight should be eliminated from reading and spelling instruction; 2) four should be used only with caution; 3) only six were simple enough to understand and, with few exceptions, to apply to a large number of words. However, 29 of the generalizations (including Clymer's 24, 18 acknowledged and 6 not) reached Clymer's criterion: 75% utility.

Burmeister (1967 V) reviews all of the previously mentioned studies as well as her own. In Burmeister's own 1966 study, the sample words were chosen from 14 frequency levels of Thorndike and Lorge's The Teachers' Word Book of 30,000 Words.

> She took a 5 percent random sample at each of eleven levels for words which occur from six to over 100 times per million running words, and a somewhat smaller (percentage wise) sample at three levels for words which ranged in frequency from one to five occurrences per million running words. She looked at generalizations which are frequently found in materials at the fourth grade level and above and also at generalizations which she had formulated through her own teaching experience. She tripled the number of sample words for her analysis of adjacent (double and

> triple) vowels and inductively arrived at generalizations which describe the sounds of such vowels [Burmeister, 1968 V].

Burmeister equates "easy" and "difficult" with "frequent" and "infrequent" words, respectively. She concludes that the "...level of difficulty of words, in general makes little difference in the utility level for a generalization...[Burmeister, 1968 V]." Her experimental design, however, is not sensitive to the problem indicated. By using a large number of groups (14), she reduced the amount of variance between each group due to word frequency, thereby reducing the probability of obtaining significant difference among them.

From the comparison of her own and other studies, Burmeister first eliminated generalizations which she considered to be infrequently encountered in instructional programs and of little value in terms of application. She then grouped the remaining 32 phonics generalizations into two classes: "generalizations considered of limited usefulness" (n = 8), and "especially useful generalizations" (n = 24). As with the other phonics generalization studies reviewed in this paper, Burmeister's specific rules are not being reported because they are stated in indefinite and/or questionable terms, and letter environments are rarely taken into consideration.

CURRENT LINGUISTIC FORMULATIONS: VENEZKY AND OTHERS

The foregoing review represented a sample of the nature of reading research in the area of phonics and word attack. It was based upon the assumption that the English orthographic system was very irregular. Most researchers failed to realize that a classificatory system for orthography consists of a set of arbitrary judgements. It is the theorist's role to specify the nature of his rules and the number of deviations from those rules that he is willing to tolerate. This section will present the theoretical base for the proposed experimental program. In addition, a review of pertinent literature consistent with these assumptions will be included.

Our base will rely, to a large extent, upon the work of the following authors: Richard Venezky and Ruth Weir (Venezky, 1967, 1966; Venezky & Weir, 1966; Weir, 1964 V), W. Nelson Francis (1963, 1958 IV) and Axel Wijk (1966 V). These authors express the conviction that English spelling and pronunciation are more regular than was previously thought to be the case. "English words, about 90 to 95 percent of the total vocabulary, do in fact follow certain regular patterns in regard to their spelling and pronunciation [Wijk, 1966 V]." A thorough analysis of English pronunciation may be found in Wijk, Regularized English, published by the University of Stockholm, 1959.

Francis also emphasizes the systematic nature of English pronunciation (Francis, 1963, 1958 IV). He demonstrates the regularity of English phonotactic rules with an explanation of Shaw's now hackneyed trick word, ghoti, enumerating the reasons for excluding ⟨fish⟩ as an acceptable pronunciation for the word. Furthermore, Francis rejects models of reading which assume that meaning can be derived directly from the printed page. He also rejects models that assume writing simply represents sounds which must be identified before understanding can take place. These models are "unduly simplistic and hence inaccurate [Francis, 1963 IV]."

Francis (1963 IV) states that an expert native speaker can be represented by the following model:

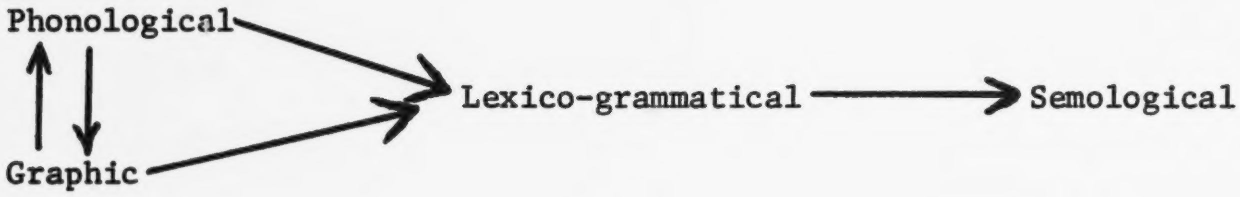

Fig. 3. Native reader

This model involves the interrelationship of four systems:

1) A graphic system, whose units are graphemes, combined and arranged according to a set of graphotactic rules, governing position and grouping, in graphic words, phrases, and sentences.
2) A phonological system, whose units are phonemes, arranged according to a set of phonotactic rules in syllables, phonological words, phrases, and sentences.
3) A lexico-grammatical system, whose units are morphemes, combined and arranged according to a set of morphotactic and syntactic rules in words, phrases, and sentences [Francis, 1963 IV].
4) A semological system, an analysis of language in terms of meanings[3] (As stated in the introduction, comprehension is not within the scope of this paper, thus discussion of this model will be restricted to the first three systems).

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[3] Explanation provided by authors.

The semological system was included to show that, according to Francis, a native reader does not go directly from either speech or writing to meaning. The problem of reading acquisition skills concerns itself mainly with deriving from the graphic system, language with which the child is already familiar. Figure 4 represents a model for the beginning reader:

Graphic ⟶ Phonological ⟶ Lexico-grammatical

Fig. 4. Beginning reader
(Francis, 1963 IV)

"Advocates of strictly phonemic writing systems and of an uncompromising 'phonic' method for teaching reading have this model in mind, even though they may not always expressly state it. But since it is an inaccurate representation of the expert native reader's skill, which is the ultimate goal of reading instruction, any method of instruction based exclusively on it cannot succeed [Francis, 1963 IV]." Francis does feel, however, that for the beginning reader the best possible print-to-speech fit is desirable. For the advanced reader this is not as important. The identification of morphemes, perhaps, becomes more valuable than the identification of phonemes. Francis' analysis may be viewed as an approximation to Venezky's work. It does not, of course, match the extent of Venezky's coverage; moreover, the morphemic structure of English is not related to spelling and sound rules to the extent of Venezky's analysis.

According to Venezky, English orthography is composed of two basic sets of patterns. The first is concerned with the internal structure of the orthography, including letter classes (graphemes) and allowable sequences of these classes (graphotactics). These are based entirely upon graphical considerations which any non-literate person must acquire. The second is a set of patterns of permissable phoneme sequences (phonotactics). The child about to begin reading has already learned these patterns and must learn to relate them to orthographic stimuli (Venezky, 1967 V).

These patterns, in order to be moderately exhaustive, become complex due to the nature of our spelling sytem:

> It may be of interest to state briefly the reason why English spelling is so much less satisfactory than the spelling of other European languages. There are mainly two reasons for this. In the first place the English spelling system arose during the late Middle Ages through a merger of

> two completely different languages, Anglo-Norman French and native English. It therefore represents a mixture of the principles of two very different orthographical systems, one of romance and the other of teutonic origin. Secondly, English spelling has remained essentially the same since the days of Caxton and the other early printers in spite of the fact that the language has undergone very sweeping changes in its pronunciation, especially in the case of the vowel sounds. As a result of these changes English vowels have in a very large number of words assumed totally different values from those that are found in the corresponding words in the related languages of the continent [Wijk, 1966 V].

Venezky and Weir advance the hypothesis that "...English spelling is not simply a defective phonemic system for transcribing speech, but instead a more complex and more regular set of patterns in which both phonemic and morphemic elements share leading roles [Venezky & Weir, 1966 V]."

A consequence of this hypothesis is that attempts to correspond spelling directly to sound cannot account for a large percentage of patterns in the orthography. An intermediate level, from which phonemic and morphemic elements can be derived, must be used. Venezky and Weir have developed such a model for mapping first from spelling onto a morphophonemic level, through various morphophonemic alternations, and finally into sound. "This is not to claim that the orthography is a morphophonemic system, but only to say that the orthography fits more snuggly into a morphophonemic model than into a direct spelling-to-sound one [Venezky & Weir, 1966 V]." A morphophonemic level is an intermediate level between grapheme and phoneme corresponding to the traditional definition of morphophonemes, with the addition of "...things that deviate slightly from the traditional concept of the morphophoneme [Weir, 1964 V]." This level is not strictly a morphophonemic level; its primary function is to separate graphemically dependent rules from grammatically and phonologically dependent ones (Venezky, 1967 V).

Another principle stemming from the hypothesis that English is a complex, but systematic orthographic organization, is the obsolescence of the categories of regular and irregular (see Fry, Clymer, Bailey, etc.). Correspondences that are irregular from a phonemic consideration may be regular from a morphemic standpoint. These catagories usually originate from examinations of frequency of occurrence of a particular pattern. These decisions are arbitrary, and irregular patterns usually represent patterns which are describable. Furthermore, these former descriptions are amenable to changes contingent upon corpus size. Thus, a small corpus would contain more irregular patterns than a large corpus (Venezky & Weir, 1966 V).

Language-dependent units on the graphemic level which are used to predict sound are called functional units. These are divided into two classes: relational units and markers.

> A relational unit is a string of one or more graphemes which has a morphophonemic correspondent which cannot be predicted from the behavior of the unit's smaller graphemic components.
> A marker is a string of one or more graphemes whose primary function is to indicate the correspondences of the relational units or to preserve a graphotactical or morphological pattern. It has no sound correspondence [Venezky, 1967 V].

Within the relational unit designation, patterns are divided into major and minor categories based upon frequency of occurrence. Although the classification appears arbitrary, it does distinguish between productive, frequently occurring patterns and infrequent patterns which generally occur in a limited number of borrowings. An example of major and minor relational units is presented in Figure 5.

Major relational units

Consonants						Vowels			
Simple					Compound	Primary	Secondary		
b	gh	n	s	w	ck	a	ai/ay	ie	ue
c	h	p	sh	y	dg	e	au/aw	oa	ui
ch	j	ph	t	z	tch	i	ea	oe	
d	k	q	th		wh	o	ee	oi/oy	
f	l	r	u		x	u	ei/ey	oo	
g	m	rh	v			y	eu/ew	ou/ow	

Minor relational units

Consonants		Vowels
Simple	Compound	Secondary
kh	gn	ae
sch		eau
		eo
		uy

Fig. 5. Major and Minor Relational Units

(Venezky, 1967 V).

As shown in Figure 5, relational units are classed as consonants or vowels, contingent upon the class of morphophonemes into which they are mapped. Some relational units are classed as both consonants and vowels (e.g. u in language is a consonant and in during a vowel).

Only graphemes that are mapped into zero can be classified as markers. Graphemes with non-zero morphophonemic correspondences, classed as relational units, can perform marking functions (e.g. the i in city corresponds to /i/, but it also marks the correspondence c→/s/).

> The strongest evidence for a separate class of markers in English orthography is found in orthographic alternation patterns. For example, final e as a marker for the pronunciation of a preceding c or g is dropped before a suffix which begins with a letter that will perform the same function as e. Therefore, notice drops the final e before ing (noticing) since i also marks the corresponding c - //s//, but retains the e before able since noticeable [if spelled noticable] would have c - //k//. Similarly, the e added to an otherwise terminal u is dropped before any suffix since the only function of the e is to avoid having word-final u, e.g., argue, arguing [Venezky, 1967 V].

Venezky discusses four kinds of influences to be considered in the application of rules on the morphophonemic level: types of correspondences, morphemic features, form class, and phonotactical influences.

Types of correspondences. Regular and irregular correspondences are used to indicate high and low frequency (Venezky concedes that he uses no rigorous statistical criteria for these designations). Regular spelling-to-sound correspondences can be classed as either invariant or variant. The letter f is offered as an example of invariance because it corresponds regularly to /f/ (in a 20,000 word corpus only one deviation, of, was encountered). Examples of other invariants are consonant units such as: ck, m, v and z. Vowel spellings are rarely invariant, although they are classified as variant regular-spellings rather than irregular spellings in most cases.

Venezky and Weir present an analysis of the vocalic system of English. A presentation and discussion of this material will be deferred until the accompanying paper on phonics has been completed.

Variant correspondences are regular, but relate the same spelling to two or more pronunciations depending upon regular graphemic, phonological, or grammatical features. For example, c corresponds to /s/ when it occurs before e, i, y plus a consonant or juncture; for most other positions it corresponds to /k/. Position may determine the correspondence of spelling units. Initial *gh*, for example, always corresponds to /g/. Medial and final *gh* have other pronunciations than /g/. Stress is also a conditioning factor for regular, variant correspondences. A simple example cited is the stress conditioning that occurs in the correspondences for intervocalic x, which usually corresponds either to /sk/ or /gz/, depending upon the position of the main word stress (/ks/ when stress precedes *x* as in *axiom*, /gz/ when stress follows *x* as in *exist*).

Irregular spelling-to-sound correspondences present a great deal of difficulty for beginning readers. Venezky illustrates irregular correspondences with two examples: *arcing* and *cello*. Both have irregular correspondences for the letter *c*, yet they differ markedly. *Cello* is a borrowed spelling from Italian. *Arc*, from which the word *arcing* is derived, has the appropriate correspondence for *c*. Suffixes which begin with *e*, *i*, *y*, when added to words ending in *c*, insert *k* after the *c*, as in *picnicking*. *Arcing* does not follow this rule and is therefore an irregular derivative.

Morphemic Features. Morpheme boundaries must be known in order to predict certain types of correspondences. The following examples (Venezky, 1967 V) serve to illustrate this:

1) Within graphemic allomorphs, geminate consonant clusters (as in *letter*, *add*, and *canned*) are pronounced as single consonants. Across morpheme boundaries, however, both graphemic consonants may correspond to separate phonemes, as in *midday* and *finally*.
2) All of the digraph and trigraph spellings are subject ot the same morpheme boundary problem as *ph*, e.g., *hothead*, *changeable*.
3) The spelling *n*, before spellings in the same morpheme which correspond to /g/ or /k/ corresponds to /ŋ/, as in *congress*, *finger*, *anchor*. Across morpheme boundaries this generally does not hold, e.g., *ingrain*, *ingenious*, *ingratiate*.
4) Many word final clusters contain silent letters, e.g., *gm*, *gn*, *mb* (e.g, paradigm, sign, and bomb). Before certain morepheme boundaries, the silent letter remains silent, as in *paradigms*, *signer*, and *bombing*. As long as the morpheme boundary is recognized, the correct pronunciation can be predicted. If the morpheme boundary is not recognized, then the three forms above would be thrown together with *stigma*, *ignite*, and *bamboo*.

Form Class: Form class identification is necessary in order to arrive at correct pronunciations. In some cases, a phonotactical analysis is adequate; in others, morphemic relations must also be specified. For example, the pronunciation of any form ending in *nger* or *ngest* cannot be predicted unless the morphemic identities of *er* and *est* are known. If they represent the comparative and superlative markers, then *ng* is pronounced /ŋg/ as in stronger; for most other instances the /ŋg/ cluster reduces to /ŋ/, as in its word final position.

Phonotactical influences. Knowledge of permissible and non-permissible phoneme sequences is an essential factor in the analysis of spelling-to-sound correspondences. Consonant clusters such as /pb/ and /bp/ do not occur in English words. Where these letter sequences appear, as in *subpoena*, the speaker drops one of the sounds. Many spelling-to-sound patterns which can only be described with difficulty on the direct spelling-to-sound level, can be described more adequately in phonological terms. A preceding /w/, for example, changes /ae/ into /a/ when the vowel is not followed by a velar consonant or /f/, as in *swamp*, *quadrant*, *quality*: *wag*, *quack*, *wax*.

With the material presented thus far as background, Venezky and Weir's model for the description of spelling-to-sound relationships can now be presented:

> In this model, graphemic words are divided into their graphemic allomorphs and, then, these allomorphs are related to intermediate (morphophonemic) units to phonemic forms. All rules which are based upon non-graphemic features are applied in an ordered sequence on the morphophonemic level, yielding various sub-levels of intermediate forms for each word. The final morphophonemic form is then mapped automatically onto the phonemic level [Venezky 1967 V].

A step-by-step example of the application of these rules makes the model more comprehensible. Let us consider the words *president*, *presidency*, and *presidential*. There is a morphophonemic sound-change rule which states that /t/ or /k/ at the end of a morpheme becomes /s/ when followed by the sounds /i/ or /y/. Rule 1: /t,k/→ s /___/i,y/. Therefore, when the morpheme suffix /i/ is added to the morpheme /prezident/, the /t/ becomes /s/ and the word is pronounced /prezidensi/ rather than /prezidenti/.

There is a second rule that states that /š/ or /ž/ at the end of a morpheme becomes /s/ or /z/ respectively when followed by the sounds /i/ or /y/ plus a vowel. Rule 2: /s,z/ + /i,y/ /š,ž// __ vowel. Consequently, when the morpehme suffix /iael/ is added to the morpheme /prezident/, the /t/ becomes/s/ by Rule 1, and this /si/ becomes /š/ by Rule 2.

Graphemic:	*presidency*	*presidential*

Morphophonemic	//prezident + i//
	//prezidens + i//
		//prezident + iael//
		//prezidens + i + ael//
		//prezidensi + ael//

Phonemic:	/prezidensi/	/prezidenšael/

What makes these rules important is tha they apply not only to these word derivations but also to the derivation of a large number of words (such as *logician* from *logic*, *racial* from *race*, *gracious* from *grace*, *erasure* from *erase*, etc).

> Spelling units are not related directly to sound, but to an intermediate (morphophonemic) level first, and then to sound. This indirect approach allows a clear separation of rules based upon orthographic considerations from those based upon morphological and phonological ones. Rules employed in mapping from graphemic to morphophonemic forms are those which are theoretically unique to the reading process. All other rules exist apart from the orthography and are, in general, a part of the language habits of all speakers of English, literate or illiterate [Venezky, 1967 V].

The value of Venezky and Weir's work lies chiefly in their specification of an explicit subject matter upon which subsequent reading research studies may be based.

UNIT SIZE

An important aspect of word identification, where little consensus has been reached, is the proper units for the perception of written words. Edelman (1963 VIII), and Marchbanks and Levin (1965 VIII) report on what appears to be the same experiment-studying the cues by which children recognize words. The purpose of this experiment was to determine: 1) What are the cues in a word by which nonreaders and beginning readers remember that word? 2) Are the same cues utilized in recognizing a long word and a short word? 3) Do nonreaders and beginning readers utilize the same cues? 4) Do boys and girls use the same cues? The procedure followed was a delayed recognition task using three- and five-letter nonsense syllables. Stimulus words on cards were presented and then withdrawn. Next, the *S* was asked to choose the word he had just seen, or the one most like it, from a group of words randomly arranged on a response card. The response cards contained systematic errors, with one cue held constant and the others varied. In the trigram series, four cues were systematically examined: word shape, first letter, second letter, and third letter. In the quingram series, shape and the five letter positions served as cues.

Word-shape was defined by whether the letters were above, below, or on the line. Curvature and angularity apparently were not taken into account. All the letters were in lower case type. The Ss were 50 kindergarten and 50 first-grade children.

The results showed that:

1) Letter cues, and not word-shape cues, are the bases by which both non-readers and beginning readers recognize words.

2) The first letter of both the long and short word forms was the cue most utilized.

3) The last letter in both word forms was the second most-utilized cue for all Ss except the first-grade girls, who knew the alphabet well (they tended to use the letter cues in sequence, the first being the most important cue, the second letter next, etc.)

4) Some kindergarten boys used the last letter as a cue more often than the first letter. Possible explanations for this are that these boys have not yet internalized the left-right sequence in reading, or that, for them, the recency effect was more operable than the primacy effect.

5) The last letter is a more important cue in three-letter words than it is in five-letter words.

6) The least used cue in both the trigram and quingram series was word-shape. Shape was shown to be significantly weaker than the weakest letter cue for all groups of Ss in the trigram series, and for three of the four groups of Ss in the quingram series.

Thus, "theories which propose that beginning readers recognize words as wholes by their shape have not been supported by this study ....Rather, this study indicates that recognition is based on individual letters. Furthermore, the first letter in particular, and also the last letter of a word are the most salient cues used by subjects who are not very familiar with the alphabet [Marchbanks & Levin, 1965 VIII]." Edelman's 1963 report and Marchbank and Levin's 1965 report both give the same two explanations for the "first-last" letter phonomenon: that it is due to primacy and recency effects, and that the first and last letters stand out because they are isolated on one side by a white space, whereas middle letters are embedded in other letters. Word-length was not, but probably should be, studied as a recognition cue. Shape might have had more effect with varying word-length alternatives. Very few of the stimulus words were cited in the reports, so it was not possible to determine whether the second letter in the trigrams and second and fourth letters in the quingrams were usually vowels. It would certainly be illuminating to know if the least-used cues tended to be vowels. If such were the case, two possible explanations are offered: that vowels might be less distinguishable from each other than are consonants because vowels are more similar in configuration (primarily being curved and non-protruding); and that vowel graphemes have more variant pronunciations than consonants, and, therefore, may be less depended on as information carriers. It would also be pertinent to know if the middle letter was utilized as a cue more often, when it was the only protruding letter in the word.

Bishop (1964) studied the transfer value of training with individual letters compared to whole words, and investigated the role of grapheme-phoneme associations in reading. A three-stage transfer design was employed. The letters were 12 Arabic characters, each with a one-to-one letter-sound correspondence. The Ss, college students, were divided into three groups: a letter training group, a whole word training group, and a control group. In Stage 1 of the experiment, all Ss learned to pronounce the transfer words to be used in Stage 3. Stage 2 varied, with each group receiving either letter, word, or no training. In Stage 3, all Ss read and pronounced the set of words they had heard and pronounced in Stage 1. At the close of Stage 3, all Ss were tested on their ability to give the correct letter-sound following the presentation of each printed letter. They were then asked to explain how they tried to learn the transfer words.

Learning took place in the fewest trials for the letter-trained group, in the next fewest for the word-trained group, and in the most trials for the untrained group. Thus, letter training had more transfer value than word training, but the latter did produce some transfer. The differences in the letter-trained and word-trained group performance were:

> almost entirely due to the differences in percentage of Ss applying grapheme-phoneme associations in the two groups. Letter training provided a propitious opportunity for Ss to form the associations and probably influenced Ss o apply them to reading words. Word training left open the possiblity that Ss might set themselves to learn grapheme-phoneme correspondences. Word training....had strong transfer value for that portion of the Ss who learned and applied grapheme-phoneme associations and little or no transfer value for those who did not [Bishop, 1964 VIII].

Thus, the whole word was found to be a possible but uneconomical training unit, and grapheme-phoneme correspondences were found to be the important factor for independent decoding of new graphic combinations. However, generalizability to beginning reading instruction might be hampered by Bishop's use of adult Ss who are highly practiced in the general process of word identification.

Samuels and Jeffrey (1966 VIII) conducted an experiment with 5-year-old Ss to determine whether a single letter might serve as a cue for a whole word response. Using the paired-associate anticipation method, three groups of 12 kindergarten Ss, and two groups of 12 nursery school Ss, were taught lists of words that differed in discriminability. Discriminability was defined in terms of the number of different letters (either four, six, or eight) used to construct the four two-letter words in each list. An artificial orthography was used; the correct responses were English CV words assumed to be in each S's repetoire.

It was hypothesized that:

> When a list is made up with no letters in common among the words, the Ss are more likely to identify new words on the basis of a single letter than when they are forced to utilize each letter in each word of the original list. To the extent that new words are identified on the basis of a single letter, transfer would, of course, be very poor [Samuels & Jeffrey, 1966 VIII].

In other words, with similar words, more identification errors are made, but greater transfer results due to utilization of more cues.

The methodological delineation between the "acquisition" groups (kindergarten Ss) and the "transfer" groups (nursery school Ss) was not clearcut. The Ss in both groups were presented serially with the four words on their assigned lists for three trials. On subsequent trials, a new letter was substituted for one of the letters in each of the original words. The authors do not indicate which letters were added. They also do not indicate whether the substitutions were the same for each trial and for all groups.

> The new letter appeared half of the time in the first position and half of the time in the second position so that each original appeared once in combination with the new letter, and the original letter always appeared in its original position. Thus, if S had learned to respond to any of the words in the original list on the basis of only one letter, he should not notice a change in at least half of these new pairs and he should provide the response he had previously learned to that letter without hesitation [Samuels & Jeffrey, 1966 VIII].

The acquisition groups, which were to be testing the effect of number of words on acquisition, were given 20 trials. The response measure was the number correct. The transfer groups, which were to be testing the transfer of cues used in learning reading responses, were trained to a criterion of two successive correct trials and then given a transfer test. It is not stated whether this test was composed of the original words or of the words with one letter changed.

For the acquisition groups, the Ss who learned the more dissimilar words made significantly fewer errors. But for the transfer groups, those who learned the more dissimilar words made significantly more errors on the final test of the original four words, although they reached criterion in fewer trials. From this evidence, the experimenters conclude that:

> the number of Ss who make identification on the basis of a single letter increases with the number of letters on which they were trained, that is, increases with dissimilarity of stimuli. Thus, as hypothesized, training that forces attention to each letter is less likely to lead to subsequent reading errors than training which permits the child to identify words on the basis of a single feature [Samuels & Jeffrey, 1966 VIII].

If this conclusion is validly made from the evidence reported, it would support a theory that the proper unit for word recognition is smaller than the whole word but larger than the individual letter. Other researchers whose work would also support this theory are Silberman (the Consonant-by-VC Syllable matrix, 1964a V), previously discussed, Rodgers (the Vocalic Center Group, 1967 V), to be discussed later in this paper, and Gibson, et al. (1962, 1963 V). Gibson states that:

> it is the letter-group which has an invariant relationship with a phonemic pattern. Whole words usually have such a relationship; but often they can be broken into smaller clusters of letters which still have the kind of relationship referred to when they are in a stated position relative to other such clusters. The clusters may be of different sizes and the rules for the grapheme-phoneme correspondence are conditional on what precedes or what follows [Gibson, et al., 1962 V].

These clusters are not arbitrary groupings of letters, such as bigrams or trigrams. The relevant graphic unit is a functional group of one or more letters, in a given position within the written word, which is in correspondence with a specified pronunciation (Gibson, et al., 1963 V). Rules for pronunciation, framed in terms of vowel and consonant spellings, are applicable even when the letter-sequences generated by them are meaningless nonsense sequences. "The rules are, presumably, inferred from real words already encountered and thereafter transfer to the perception of new words and also to the perception of pseudo-words, irrespective of meaning [Gibson, et al., 1963 V]." These regularities in spelling-to-sound predictability may be termed spelling-to-sound correlations, or grapheme-phoneme correspondences.

Gibson, et al. (1962 V) hypothesizes that the reading task is essentially that of discovering these higher-order invariants, the grapheme-phoneme correspondences. These constants are presumably discovered by exposure to both the graphic and the phonemic stimuli at the same time and in different contexts, so that the invariant combinations can be recognized in many different words. This hypothesis cuts across the dichotomy of stimulus- and response-frequency by proposing that the critical unit to be considered in word-recognition involves both--that it is, in fact, a stimulus-response correspondence which the individual becomes skilled in detecting as it recurs in an invariant relationship in different words. Neither frequency of visual exposure alone or emitting the oral response alone is of significance. Rather, it is the frequency of experiencing a grapheme-phoneme coincidence which leads to skilled recognition.

GIBSON CORNELL GROUP

From their hypothesis that letter-pattern groups are the proper unit for word perception, Gibson et al. (1962, 1964, 1966 V) predict that a skilled reader (whether or not he can verbalize the rules) should be able to discriminate better visually, those letter-patterns in new words which are constructed according to the rules of grapheme-phoneme correspondence (found in the structure of written and spoken English) than ones which are not, or are only partially so. These would apply even for pseudo-words. A series of experiments was performed by Gibson and her associates to test this hypothesis (1962 V). Two qualifications, however, must be kept in mind while reading these experiments: 1) That when the term "invariant" pronunciation is read, one should consider it as being relative rather than absolute. When the Ss' pronunciations of the experimental words were analyzed by linguists, only one-fourth of the "pronounceable" words (those said to have invariant pronunciations) were found to have been given the same pronunciation by all Ss. The majority of the "pronounceable" words, however, had from five-to-fourteen different pronunciations (1962 V). 2) Pronunciability ratings ("ease" of pronouncing a given letter-sequence) are used as indicators of invariance of grapheme-phoneme correspondences. The investigators justified this procedure because both the set of rating scores and the set of scores for variability of pronunciation for the 50 words used in the experiments were transformed into standard-scores and correlated by means of a Pearson r, and a positive correlation of .85 was found (not corrected for attenuation). The magnitude of this correlation, they propose, suggests that "the rules of grapheme-phoneme correspondence, which exist objectively in the language, are reflected psychologically in individual ratings of pronunciability of words and also in group conformity of pronunciation [Gibson et al., 1962 V]."

In a preliminary experiment, three lists of pseudo-words were presented tachistoscopically (Gibson, et al., 1962 V): 1) "one with an invariant relation between spelling and sound...." Their example of this category is the nonsense syllable, NOOSH. The *OO*, however, can be pronounced in at least two ways, as in *noose* or *nook*. Thus, it is not invariant. 2) "One in which all the words were pronounceable, but there were two alternative pronunciations...." Their example is the nonsense syllable, DRIEND, but the *IE* can be pronounced in more than two ways, as in *dries*, *friend*, *fiend*, *client*. 3) "And one in which the words had low spelling-to-sound correlation (were relatively unpronouncable by rules of Englsih pronunciation, e.g., SCRIGW) [Gibson *et al*., 1962 V]." After the words were exposed, each only once, the 21 *Ss* were to write what they saw and guess when they could. Results were scored right or wrong for the whole word. The mean number correct was about twice as great for the two pronounceable sets of words as for the unpronounceable set. A Tukey-test for multiple comparison of means showed that the means for the two prounceable series were both different from the unpronounceable series, but not from each other.

Before proceeding to the two experiments accompanying the preliminary study, several comments regarding the three studies are appropriate. The hypothesis in the preliminary experiment predicted "...that skilled readers would discriminate visually pseudo-words constructed according to the rules of spelling-to-sound correlation better than words which are not, or are only partially, so constructed [Gibson, *et al*. 1962 V]. However:

1) The only significant differences obtained were between the unpronounceable (U) group and the two pronounceable (P) groups. The unpronounceable list violates English phonotactic rules and so comparisons involving these unpronounceable words cannot generalize to considerations of reading acquisition.

2) The differences between the invariant pronounceable list and the variant pronounceable list were not investigated. A comparison of these two conditions would be of greater value in generating information in reading instruction.

3) As mentioned previously, the invariant group was not truly invariant, conforming more to the specifications of the variant list (two alternative pronunciations). The variant list, had more than two alternative pronunciations.

4) Summed letter frequencies were not controlled in the selection of stimulus words in the preliminary experiment. This was corrected in Experiments One and Two. Despite the aforementioned comments, this was the first attempt to relate the perception of words to grapheme-phoneme correspondences and occupies an important place in the reading literature.

The basic design of these experiments was to compare the perceptibility (with a very short tachistoscopic exposure) of two sets of letter-strings, all pseudo-words, which differed in their spelling-to-sound correlation. One list, called the "pronounceable" list, contained words with a high grapheme-phoneme correspondence. Each of them had an initial consonant-spelling with a single, regular pronunciation; a final consonant-spelling having a single, regular pronunciation; and a vowel-spelling, placed between them, having a single, regular pronunciation when it follows and is followed by the given initial and final consonant spellings, respectively--for example, GL/UR/CK. The words in the second list, called the "unpronounceable" list, had a low grapheme-phoneme correspondence. They were constructed from the words in the first list by reversing the initial and final consonant spellings. The medial vowel spelling was not changed. For example, GLURCK became CKURGL. There were 25 such pseudo words in each list, varying in length from four to eight letters. The pronunciability of the resulting lists was validated in two ways, first by ratings, and second by obtaining the number of variations when the pseudo-words were actually pronounced.

The words were projected on a screen in random order, in five successive presentations with an exposure time beginning at 50 milliseconds and progressing up to 250 milliseconds. The Ss (college students) were instructed to write each word as it was projected. The mean percentage of pronounceable words correctly perceived was consistently and significantly greater at all exposure times. It is interesting to note the types of errors made in this first experiment. As might be expected, due to reading from left to right more errors occurred for the final consonant-spelling than for the initial one. But the difference between words of the P (pronounceable) and (unpronounceable) lists was still present ($p < .01$ by a Chi-Square test for both initial and final clusters). Errors also increased with length of word (See McGinnies, 1952 VIII) for a study of the effect of word length on perception).

> The difference between P and U words occurred for all lengths of word but was smallest for four-letter words and greatest for five-letter words. The interaction could not be measured, since the number of cases for the different lengths of word was not equal, but the difference is quite obvious. A short word of four letters is so seldom missed that the difference between P and U can have only a small effect. On the other hand, a word of eight letters is so difficult that not even pronunciability will permit perfect discrimination to occur with great frequency [Gibson, et al., 1962 VIII].

"Real" word errors occurred infrequently, probably because the Ss were told in the instructions that they would be shown "nonsense" words. More real words were given for P combinations than for U combinations, 27 versus 15. But the difference could scarcely be significant out of 6250 possible responses--25 Ss x 50 words x 5 trials--although the authors might have meant 27 and 15 differnet words. Errors which changed the projected letter-group in the direction of a more pronounceable one were frequent. This was accomplished in some cases by adding a vowel (e.g., NIKID for NKID), by omitting a consonant (e.g., SKEB for SKSEB), or by changing a consonant-cluster (e.g., BLUS for LBUS). Errors of omission were more frequent for the unpronounceable words, and occurred most for the longer words, but did not occur often.

In an attempt to eliminate a response-bias for pronunciability, the experiment was later repeated with the same material but a different judgment. After the pseudo-word was exposed, it was followed by a multiple-choice list of four items, one of the correct one and the other three the most common errors produced in the previous experiment. The S chose the word he thought he had seen from the choice list and recorded a number (its order on the list). Again, the mean of pronounceable pseudo-words correctly perceived significantly exceeded that of their unpronounceable counterparts. Hopefully, the experimenters' conclusion is valid that skilled readers more easily perceive as a unit pseudo-words which follow the rules of English grapheme-phoneme correspondence--that spelling patterns which have invariant relations to sound patterns function as a unit, thus facilitating the decoding process. Of course, there is a problem here in that the responses might have been affected by the alternatives (distractors). Also, it seems that one could not state definitively that response-bias is eliminated in a multiple-choice situation. It would perhaps be of value to investigate the effect of varying the response modes by saying the word aloud, spelling it aloud, writing it, or matching it in a multiple-choice situation. In these experiments the pronunciation ratings were made by other Ss in pilot studies; it would be important to know how reliably these ratings could be generalized to another population of Ss. Possibly this could be determined by comparison of the experimental scores of two groups. The first group would be exposed to all the experimental words (both stimuli and response alternatives) prior to the experiment, to determine each S's pronunciation of each word and his rating of the ease of pronunciation. This, of course, would alter his response availability hierarchy for the experiment. The second group would not have prior exposure to the words, but the pronunciation ratings from the first group would be used to analyze the responses made by the second group.

Two other experiments have studied the effect of pronunciability on perception, learning, and retention of words. Underwood and Schulz (1960 V) had Ss learn serial lists of psuedo-words which had been rated for pronunciability and frequency. The product-moment correlations between pronunciability and learning for four lists was .86, .76, .90, and .95. The corresponding rank-order correlatations were .95, .90, .90 and .98. For one of the lists, rank-order correlations were determined between pronunciability and learning for each subject. These correlations ranged from .16 to .95, with a mean of .59. "Clearly, an astonishingly large proportion of the variance [.36] is accounted for by the pronunciability dimension [Underwood & Schulz, 1960 V]." In nearly every instance where pronunciability ran counter to frequency, the learning scores covaried with pronunciability rather than with frequency. Rank-order correlations between frequency and learning for the four lists were .42, -.07, .83, and .95. Rank-order correlations between frequency and pronunciability for the four lists were .45, .17, .87, and .91. It is clear that whenever the correlation between learning and frequency was low, the correlation between frequency and pronunciability was also low. Gibson says in this regard that:

> Insofar as frequency has a role in the constitution of these units, it is the frequency of grapheme-phoneme coincidence which is crucial, not frequency of exposure to the seen or uttered units alone. The reading of words is thus inseparable from the hearing of words. Since the hearing of words is also inseparable from the speaking of words, reading must be conceived, however, as part of a circular response-process, not simply as a stimulus-response process [Gibson, et al., 1962 V].

Another experiment by Gibson, et al. (1964 V) compared meaningfulness and pronunciability as grouping principles in the perception and retention of verbal material. Thresholds of visual perception and two measures of retention were obtained for trigrams varying in pronunciability and meaningfulness (semantic reference of the kind found in well-known initials), and for control items. The three types of trigrams contained the same letters rearranged into anagrams (e.g., KOR, RKO, and OKR). Perceptual thresholds were lowest for pronounceable items, and next lowest for meaningful ones. On the other hand, retention, measured by both recognition and free recall, was best for the meaningful items and second best for pronounceable ones. Pronunciability was inferred to be the better grouping principle for reading or coding to speech units. Meaningfulness was inferred to have facilitated retention more than pronunciability by providing a category for grouping the initial items, thus aiding retrieval.

Due to alternative interpretations being suggested for the Gibson, et al. 1962 experiment, the second experiment was replicated with modifications for comparison of deaf and hearing Ss. The deaf Ss, in general, made significantly more errors than the hearing Ss (M = 37.09 compared with 26.20). However, pronunciability was significantly correlated with perception of pseudo-words for both the deaf Ss and the hearing Ss. Two multiple regression analyses were made. Length and pronunciability predicted errors significantly (they must have meant "number of correct responses" rather than "errors", otherwise the positive correlations shown would mean that the more pronounceable a word is, the more difficulty one will have perceiving it). However, number of pronunciations and bigram and trigram counts were not good predictors of errors, even when these counts took into account the position of the bigram or trigram in the word and word length. "It is notable that pronunciability predicts, if anything, better for the deaf Ss [Gibson, et al., 1966 V]" (.44 vs. .33 for hearing Ss in one multiple regression analysis, and .64 vs. .38 in the other. Whether or not these differences are significant is not stated). As a result of these findings, Gibson et al. rejected four of the five alternative interpretations raised:

1) Rules of spelling-to-sound mapping suggest that mapping-invariance creates larger units for reading and therefore faster processing. This was rejected, or at least seriously weakened. "The fact that the deaf Ss were equally or indeed more facilitated in reading pronounceable spellings must mean that the mapping relation to sound is not essential--or rather, that it is not essential for the reader to experience the cross-modal invariance [Gibson, et al., 1966 V]."

2) It may be that hearing Ss rely on regular grapheme-phoneme correspondences for letter patterns, while deaf Ss rely on regular sequences for the entire pattern. Gibson rejects this idea by rejecting the second hypothesis that transitional (sequential) probabilities in written English, without regard to sound, account for the superiority of the so-called pronounceable words. However, do the bigram and trigram counts consider, for example, the probability of N followed by K followed by I plus I followed by D, or more validly, the probability of word-initial N followed by KID?

3) Words are matched to an acoustic representation before they are read. Therefore, pronounceable words are more readily perceived. This was rejected. "This is obviously impossible for the deaf Ss. Even those who were rated highest in hearing (and all hearing levels were very low) were unable to discriminate speech sounds [Gibson et al., 1966 V]." But quite possibly, learned kinesthetic discriminations are associated with letters and letter patterns.

4) Processing of letter-strings in reading involves encoding and matching to an articulatory representational plan. This was also rejected. "This seems manifestly impossible for the deaf Ss. Most of them did not speak, and speech rating--its comprehensibility and therefore differentiation--did not predict errors [Gibson et al., 1966 V]." But, can the experimenters be certain that the deaf Ss did not speak subvocally? And are comprehensibility to others and a person's ability to discriminate what he himself has said, the same or highly correlated? It does not seem to be so for a child.

5) The fifth hypothesis, though creditable, has no data to support it, and appears to have been accepted by a process of elimination.

> Complex morphological rules cover structural patterns of letters permissible in English words. Such rules are not merely transitional probabilities but are a kind of syntax, analogous to grammar. Such rules could be learned, as one learns to read, with or without relating them to speech sounds....Words are rated pronounceable because the writing

> system--and therefore morphological rules--evolved in relation to sound. Therefore, pseudo-words that follow the rules must map to sound with regularity and must be rated pronounceable.... Sound would seem thus to be not *necessarily* [emphasis supplied] a part of the individual's processing in forming higher units of reading, although historically it formed them in the spelling patterns of the written language. This conclusion finds support in Venezky and Weir's previously discussed work on the relation of spelling to sound. They found it necessary to develop a model for mapping first from spelling onto a morphophonemic level and then to sound. 'The orthography', they said, 'fits more snugly into a morphophonemic model than into a direct spelling-to-sound one'....It would appear, from the data reported, that the morphophonemic regularities available to the deaf reader are adequate for the formation of units even when the sound correspondence is not directly available to him [Gibson *et al.*, 1966 V].

However, the fact that deaf readers might not have the sound or pronunciation level does not preclude its importance for hearing readers. It is likely that sound or phonetics has a kinesthetic representation for deaf Ss. In any case, due to the questionable rejections of hypotheses, the grapheme→phoneme model should be modified rather than discarded, since a grapheme→morphophoneme→ phoneme model appears to be more appropriate.

LEARNING GRAPHEME-PHONEME CORRESPONDENCE RULES

Gibson *et al.*'s 1963 (V) study considers two different possibilities for the question of how the grapheme-phoneme correspondence rules are learned: either the child begins by memorizing whole words and later learns to formulate some of the correspondence rules, or the correspondence rules might develop as soon as he learns to speak--even though the sequence is short and the grammar is a very simple one. The experiment was designed to compare children at the end of the first grade and at the end of the third grade in ability to recognize familiar 3-letter words, pronounceable trigrams, and unpronounceable trigrams. The 3-letter words were taken from the first-grade reading list; each word chosen could be rearranged into a meaningless but pronounceable trigram and a meaningless and unpronounceable one (e.g., RAN, NAR, RNA). Some psuedo-words (four and five letters) were taken from the previous experiments and included as well. The words and pseudo-words were exposed tachistoscopically to individual children, who were required to spell them orally. By either of the hypotheses, the familiar words should be easy to recognize; the question was whether there would be a difference between the two types of trigrams at the two grade levels. If the first alternative was correct, first-grade children would read words but not pseudo-words which have never been encountered even though they fit the correspondence rules. But, if the second alternative was correct, even the first-graders would read pronounceable pseudo-words more efficiently than unpornounceable one. The results showed that first-graders of both sexes and third-grade boys read (spelled out) familiar words correctly with greatest frequency and that they read pronounceable trigrams more accurately than unpronounceable ones. The third-grade girls read all 3-letter combinations with high, and about equal accuracy, but differentiated the longer pseudo-words; that is, the pronounceable 4- and 5-letter pseudo-words were more often perceived correctly than their unpronounceable counterparts. These results suggest that a child in the first stages of reading skill typically reads in short units, but has already generalized certain consistent predictions of grapheme-phoneme correspondences, so that units which fit these simple "rules" are more easily read. As skill develops, span increases, and a similar difference can be observed for longer items. The longer items involve more complex contingency rules and longer vowel and consonant spellings, so that generalizations must increase in complexity. Thus the second hypothesis suggested is supported.

> Even though a child is presented with 'whole words' and encouraged to associate the printed word as a whole with the spoken word, he still begins to perceive some regularities of correspondence between the printed and written terms and transfers these to the reading of unfamiliar items. This generalizing process undoubtedly promotes reading efficiency and could be facilitated by presenting material in such a way as to enhance the regularities and speed up their incorporation [Gibson _et_ _al_., 1963 V].

Two other possibilities for teaching correspondence patterns are to:

1) Teach component correspondences as such, and integrate them later.
2) Teach by a two stage procedure of
   a) discrimination by differential reinforcement followed by
   b) abstraction training with presentation of items with common invariant correspondence plus a variant, and then test for abstraction of the concept [Gibson, 1966 V].

The alternatives are amenable to experimentation.

Should constant or variable grapheme-phoneme correspondences be learned first? Bloomfield (1961 V) suggested that the beginning reader should be presented with material carefully programmed for teaching those orthographic-phonic regularities which exist in English, and should be introduced later, and only gradually, to the complexities of English spelling and to the fact that single letter-to-sound relationships are often variable. Actually, there has been no evidence to suggest that transfer, later, to reading spelling-patterns with more variable component correspondence will be facilitated by beginning with only constant ones. Although variable ones may be harder to learn in the beginning, the original difficulty may be compensated for by facilitating later learning.

A series of experiments directed by Harry Levin (1961 V), and which would be supported by Samuel's and Jeffrey's findings (1966 V), dealt with the effect of learning variable, as opposed to constant, letter-sound relationships, on transfer to learning new letter-sound relationships. In one experiment, Levin (1961 V) used learning material consisting of short lists of paired-associates, with a word written in artificial characters as stimulus and a triphoneme familiar English word as response. Subjects (third-grade children) in one group were given a list which reportedly contained constant grapheme-to-phoneme relationships (one-to-one component correspondence) followed by a list in which this correspondence was variable with respect to the medial vowel sound. Another group started with a similarly constructed variable list and followed it with a second one. Levin claims that the group that learned lists with a variable component in both stages was superior to the other group in the second stage. The results, he says, suggest that initiating the task with a variable list created an expectation of learning set for variability of correspondence which was transferred to the second list and facilitated learning it. The problem is that there is a lack of congruency between Levin's hypothesis and his methodology, although the hypothesis is very useful. The rationale underlying his hypothesis is that when a given graphic symbol stands for two or more sounds, it should be learned and transferred more readily when the variations are learned together than when they are learned separately. That is because the closer two habits (responses to the same stimulus) are in the hierarchy, the more likely will a succeeding one be substituted for an unsucessful response. But if there has been overlearning on a single grapheme-phoneme correspondence, and if it does not work, the distance between habits in such a hierarchy will make it less likely for the second, which is much weaker, to be applied. However, the large number of complicated English grapheme-phoneme associations must be taken into consideration in terms of children's capacities to handle degrees of complexity. Thus, there is the question of how many grapheme-phoneme variations should be imposed on the beginning reader at the same time.

The following objections can be raised to the Levin and Watson study:

1) Only eight words, four in each stage, are used in the experiment.
2) What is referred to as a "constant pattern" consists of words similar only in medial vowels.
3) There is no valid test of transfer. Transfer items have no sounds in common with the learned lists.
4) It was stated that the transfer lists had vowels with the same graphic symbol (these were not provided for the reader). It would have been more germane to Levin and Watson's inquiry to have tested a given grapheme representing two or more phonemes (e.g., not, ton) or two or more graphemes representing the same phoneme (e.g., son, sun).

The results indicated that from high to low, the major source of confusion errors occurred when two or more words shared an initial grapheme and phoneme, terminal elements, and medial elements. But one is unable to tell if the confusion was due to common visual stimuli or common verbal responses or a combination.

In a second experiment (Levin & Watson, 1963 V), variations in the initial consonant position were studied. The first hypothesis was that with no relevant prior experiences, a variable list is learned faster than a constant list. Their hypothesis is that variable responses within a list would facilitate discrimination among the elements in the list, which in turn would make the list easier. This hypothesis was not substantiated. A constant list is easier to acquire. "Apparently the task of making varying associations to a single stimulus is harder than the single grapheme-to-phoneme association [Levin and Watson, 1963 V]." But this finding does not preclude that the variable prior experience, which was more difficult, may yield positive transfer effects to subsequent learning.

The second hypothesis was that the original variable training makes subsequent variable lists easier to acquire. This was confirmed. V_1V_2 transfer was greater than V_1C_2 or C_1V_2 or C_1C_2(V = variable list, C = constant list). The effect on a following constant list, and original constant-list training has little differential effect on later constant or variable list learning. Thus, the effects of the pre-transfer training override the constant list's being easier to learn than the variable list. The basis for confusion errors (intralist) is common visual stimuli rather than common verbal responses.

Venezky (1966 V) agrees with Levin and Watson that concurrent learning of variable grapheme-phoneme correspondences probably would have greater transfer value than would overlearning one correspondence and later being introduced to a variation:

> Understanding one of the most important spelling patterns, that of the correspondences for the primary vowel spellings, requires differentiation of both graphemic environments and responses.

The letter a, as an example, has two primary pronunciations in stressed position, /æ/ and /e/. The checked alternative, /æ/, occurs when a is followed by a final consonant or by a series of consonants, as in rat and annals. In addition, it occurs when a is followed by a single consonant plus one of several possible suffixes, like -ity (e.g., sanity). The free pronunciation, /e/, occurs when a is in the other graphemic environments, like rate, anal, and sane. What must be acquired for the proper pronunciation of a is the ability to differentiate the environments and suffixes; final consonant vs. consonant plus final e (rat:rate), double medial consonant vs. single medial consonant (annals:anal), and the base form vs. particular suffixes forms (sane:sanity).

The Bloomfieldian sequencing begins with the /æ/ pronunciation for a, introducing the /e/ pronunciation at a later time with no special emphasis on the relation between /æ/ and /e/ when derived from a. An alternative to this approach is to present both pronunciations at once, working with such pairs as rat:rate, mat:mate, fat:fate, hat:hate and man:mane. Both the associations of a to /æ/ and a to /e/ and the discrimination of the graphemic environments would be emphasized. Whether or not a child first learning to read can handle this task probably depends upon the pedagogy employed. The potential generalization derived from the differentiation approach, however, certainly is greater than that from the simple-to-complex sequence method [Venezky, 1966 V].

STANFORD PROJECT

The Stanford University Institute for Mathematical Studies in the Social Sciences has developed a computer-assisted instructional reading program. Objectives, technical specifications, curricular formulations and experimental results were presented in a series of technical reports (Wilson & Atkinson, 1967; Knutson, 1967; Rodgers, 1967; Hansen, 1966; Hansen & Rodgers, 1965 V). It is an interdisciplinary project with a psycholinguistic base.

The rationale for the utilization of a computer-assisted instructional system includes the following:

1) This type of instruction has proven quite feasible with young children, as programmed instructional literature has borne out.

2) A computer-assisted instructional system permits detailed investigation of reading hypotheses concerning acquisition of skills (Hansen, 1966 V).

3) Curriculum research and evaluation may be carried out under conditions in which the instructional materials can be specified precisely and detailed records of student performances can be kept.

4) Extraneous variables may be controlled in order to permit more rigorous interpretations (Atkinson & Hansen, 1966 V).

The Stanford project is designed to present instructional materials to 16 students simultaneously, "...and includes the possibility that each student may be working on a completely different set of materials [Atkinson & Hansen, 1966 V]." There is a steady flow of detailed data from every lesson. In addition, the Stanford project has attempted to devise specific hypotheses regarding the form and content of reading generalizations. The generalizations and acquisition hypotheses have been stated in experimentally testable formats (Rodgers, 1967 V).

The basic instructional and experimental unit devised for this program is the Vocalic Center Group. This unit was selected for its wide range of generalizability. "We deem the ability to recognize, manipulate, and associate printed sequences with vocalic center groups to be one of the generalizations that both letter and word sounding techniques imply [Rodgers, 1967 V]." Hansen and Rodgers define the vocalic center group as follows:

> The psycholinguistic unit for initial reading that we propose in the Vocalic Center Group is an elementary structure resulting from the integration of phonemic elements into a minimal pronunciation unit. The Vocalic Center Group is a structure in the sense that it is the optimally minimal sequence within which all necessary rules of phonemic co-occurrence can be stated. Such rules are commonly referred to as phonotactic rules. By integration we refer to the process whereby phonemes are positionally modified so as to form a phonotactically permissable and tolerably intelligible pronunciation. The VCG is marked by one vocalic element (which is not necessarily a vowel). Non-vocalic (consonantal) or semi-vocalic elements may occur preceeding or following the vocalic center. The "complexity" of phonotactic rules governing the phonemic combinations within the VCG, we hypothesize, are intimately related to the "difficulty" of speech production, speech perception, and we will claim, initial reading behaviors [Hansen & Rodgers, 1965 V].

The vocalic center group is defined phonologically rather than semantically. It is not identical to a syllable, but one would not be "seriously misled" if he was to follow standard dictionary syllabification rules to conceptualize the vocalic center group (Rodgers, 1967 V).

There are seven tenets basic to the Stanford Project materials; they are presented below:

1) Reading and spelling are taught independently.
2) Reading is initiated with a decoding or transfer stage during which the student learns to associate graphic patterns that look alike in a specified way with speech sequences that sound alike in a specified way.
3) The association of sight to sound is initially affected between letter patterns and VCG (or spoken syllabic) units and is meaning-independent.
4) The sequence of presentation of items in this association learning is determined primarily by a scaling of difficulty of VCG (or syllabic) units. The sequence is determined secondarily by the regularity of the orthographic and phonological correspondences, by the productivity of the items comprising a VCG set, and by the usefulness (e.g., for story-writing) of the items comprising the set.
5) Every graphic pattern is presented as a member of a rhyme set and an alliteration set, the distinguishing characteristics of these sets being displayed in a matrix format.
6) Word items presented in the matrix format, emphasizing the regularity of graphic and phonetic pattern correspondences, are immediately introduced in various sequential contexts which emphasize somewhat independently the morphological, syntactic, and semantic functions of these matrix-learned items.
7) Patterned word items appear in poems, stories, essays, and descriptions in which the features of pronunciation, grammatical function, and meaning of word items are shown to function conjointly to convey the writer's intention to the reader.

Experimental findings

The Stanford group's technical reports mention several experiments they performed. In almost every case, only a description of the article is presented; methodology is omitted. Consequently, comments on these experiments are restricted by the lack of information presented.

The first study reported by Rodgers (1967 V) attempted to demonstrate the efficacy of the vocalic center group in terms of the priorities of word division by beginning readers. In this experiment, disyllabic, bi-morphemic words were enunciated in syllables to children who were asked to repeat the words, with the same syllabification. The words were syllabified according to a "natural" morphemic and a "natural" phonological division (e.g., danc-er, dan-cer; toast-er, toas-ter. The words used in this experiment had morphological and phonological boundaries that did not coincide; in most disyllabic, bi-morphemic words, identical syllabification exists).

The results favored re-division along phonological rather than morphological boundaries. These results tended to favor the phonological definition of the vocalic center group. Furthermore, these results are consonant with Venezky and Weir's spelling-to-sound model. In this model (see pages 36-41) a two stage approach was proposed. The first, going from the graphemic level to the morphophonemic level is unique to the reading process. The second stage from the morphophonemic level to the phonological level is found in all native speakers. The results of the Stanford Project's first experiment tend to support the tenability of this second stage.

The second experiment investigated the effects of stress distortions on word recognition. There were three types of distortions:

1) Two-syllable words having normal stress on the first syllable were stressed on the second syllable with an accompanying "full" second vowel and "diminished" first vowel. The reverse would hold for normal pronunciation (e.g., carrot, normally pronounced /kérə̆t/→/kĕrát/).

2) Two-syllable words normally stressed on the second syllable were stressed on the first with similar change of vowel values (e.g., forget, normally pronounced /fə̆rgét/→/fɔ́rgĕt/).

3) Words with three medial non-contiguous, orthographic vowels, in which the orthographic medial vowel was not normally pronounced, received primary stress (e.g., general, normally pronounced /jénrə̆l/→ /jə̆nérə̆l/ and chocolate, normally pronounced /č́əklə̆t/→/čə̆kólə̆t/).

The distorted pronunciations were presented to pre-reading subjects by tape recorder, without a linguistic context. Ss were instructed to identify the words. The results indicated better than 50% one-trial recognition on the two-syllable words and better than 40% recognition on the three-syllable items. Most of the errors were errors of omission. The results:

> seem to suggest that in an almost optimal distortion condition children are able to tolerate vowel and stress anomalies such as might arise from severe over-generalization of simple syllable pattern pronunciations....This observation appears in keeping with the classical

> observation that 'the intelligibility of speech depends almost entirely on the presence of consonants (Carterette & Jones, 1965[4])'[Rodgers, 1967 V].

The third study cited taught five-year-old children to associate the appropriate sound patterns to a series of letter patterns. The stimulus items were 77 CVC items formed by taking all orthographic combinations of initial *m*, *n*, *p*, *t*, *c*, *b*, *d*, *f*, *h*, *s* and *r*; final *m*, *n*, *p*, *t*, *b*, *d*, *g*; and the medial vowel *a*. There were 31 high frequency words, "...which can perhaps be considered of 'maximal meaningfulness' to the children in Carroll's sense [Rodgers, 1967 V]." An analysis of children's relative difficulty in acquisition of "nonsense" as opposed to "meaningful" responses to the orthographically presented items, was made.

The results were presented by proportion of correct responses (responses per graphic exposure). The mean proportion of correct responses to all 77 word items for all children over all trials was .898. The mean for the 31 items defined as meaningful was .908 and for the 46 non-meaningful items .891. The data was that: "1) children can learn to associate regular pronunciations of nonsense items to spelling patterns fairly easily, and 2) for some pattern sets nonsense associations appear easier to learn than meaningful associations [Rodgers, 1967 V]."

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[4] Carterette, E.C. & Jones, M.H. Phoneme and letter patterns in children's language. In Proceedings of Symposium on the Psycholinguistic Nature of the Reading Process, 1965, Wayne State University, in press.

SUMMARY

This report is intended to serve as a summary of the recent literature on word attack. The literature is characterized by an abundance of non-experimental, prescriptive articles. Empirical investigations tend to cluster in a few areas, most notably those of word and letter discrimination.

The first half of the report deals with the major reading systems currently in use. To a large extent, these systems lack an empirical base for both their subject matter and instructional procedures. The second half of the report reviews reports of current word attack research. This research, although usually generated form a theoretical position, is largely concerned with answering isolated questions. However, the results of these studies appear to have widespread generalizability. A brief review of the major findings of these studies is presented here, accompanied by appropriate page references to this text.

Marchbanks and Levin (pp. 43-44), Bishop (p. 45), and Samuels and Jeffrey (pp. 45-47) set out to determine the stimulus units (cues) to which the reader attends, and the identification techniques he utilizes in the word attack process. Relevant findings were that: a) letter cues, and not whole-word shape cues, are the basis by which non-readers and beginning readers recognize words; b) training in making grapheme-phoneme associations has more transfer value than does whole-word training; and c) the use of single letters as cues in word identification increases with dissimilarity of stimuli and results in more reading errors than do multiple-letter cues (the latter being necessary when word stimuli are more similar).

From such research, Gibson _et_ _al_. (pp. 48-54), the Stanford project (pp. 58-62), and Levin and Watson (pp. 56-57) hypothesized that the proper unit for word recognition is the grapheme-sequence, with its corresponding, environment-influenced phonemes. They then tested the effect of this stimulus unit, the letter-group, on a _S_'s perception and learning. In a poorly-designed experiment, Levin and Watson (p. 56), confirmed their hypothesis that the learning of variable, rather than constant, grapheme-phoneme correspondences would have greater transfer to the learning of new correspondences. In another experiment (p. 57), they found that although an original constant-correspondence list results in subsequent variable lists being easier to acquire. In other words, V_1V_2 transfer is greater than V_1C_2 or C_1C_2 or C_1C_2 transfer.

The Stanford project (pp. 58-61) used an interdisciplinary approach in their computer-assisted reading instruction program. Through the collaboration of linguists, psychologists, and educators, linguistic hypotheses were posited and their efficacy for reading acquisition was investigated. The primary reading instrucitonal unit used in the Stanford project is the vocalic center group. Rules for the specification of vocalic center groups approximate, but are not identical to, dictionary syllabification rules (pp. 58-62).

In a series of experiments, Gibson et al. (pp. 47-55), confirmed their hypothesis that pronunciability (grapheme-phoneme regularity) is functionally related to perception. Upon testing deaf Ss, however, Gibson et al. (pp. 52-54) found it necessary to modify this hypothesis to include graphotactics and the morphophonemic level of rules postulated by Venezky and Weir (pp. 38-43).

Venezky and Weir have made the most complete investigation of English orthography and corresponding pronunciation to date. Their work is based on the hypothesis that "...English spelling is not simply a defective phonemic system for transcribing speech, but instead, a more complex and more regular set of patterns in which both phonemic and morphemic elements share leading roles [Venezky & Weir, 1966 V]." Unlike Venezky and Weir, investigators of traditional phonic generalization research, such as the educators Fry and Clymer (pp. 33-35), assumed that the English language, or at least its highest frequency words, is fairly irregular, and that phonics rules presently incorporated into reading programs should be taught in rank order according to proportion of applicability. These studies are of limited utility due to a simplistic view of the language and lack of rigor in experimentation. Hypothesizing that English is a systematic, though complex language, and recognizing the arbitrary nature of rules, Venezky and Weir determined more appropriate spelling-to-sound rules for reading instruction and vocabulary selection. It is their use of the morphophonemic level of rules, mediating between a grapheme, or grapheme-sequence, and a phoneme, that accounts for greater regularity in the language than that allowed for by the traditional investigators. Furthermore, the traditional investigations of phonic generalizations ended their studies with the evaluation of the rules' "utility" or proportion of applicability. Venezky and Weir, upon completion of their analysis, point out that their work is only the initial step. "We feel that the task ahead in reading research should be primarily in the hands of the psychologist [Venezky & Weir, 1966 V]."

Future research in reading instruction, hopefully, will:

1) systematically study the English language to determine an explicit subject matter; that is, extend Venezky and Weir's work;

2) use an interdisciplinary approach, as the Stanford project is doing;

3) make further investigations of the stimulus units to which the beginning reader attends, as Marchbanks and Levin, etc. attempted; and

4) empirically validate the language-based subject matter, identification techniques, and systematic instructional methodology on relevant populations (non-readers and beginning readers).

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